TO STUDY THE VALUE OF HOME-VIDEOS IN THE DIAGNOSTIC ACCURACY OF PAROXYSMAL EVENTS IN CHILDREN

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Submitted By

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I hereby declare that the thesis entitled **"TO STUDY THE VALUE OF HOME-VIDEOS IN THE DIAGNOSTIC ACCURACY OF PAROXYSMAL EVENTS IN CHILDREN"** submitted towards partial fulfillment of the requirements for the award of **MD IN PAEDIATRICS** degree to BFUHS is a compilation of original work carried out by me under the supervision of **Dr. Jatinder Singh Goraya,** Professor, Department of Paediatrics, **Dr. Siddharth Bhargava,** Associate Professor, Department of Paediatrics & **Dr. Gagandeep Singh**, Professor & Head, Department of Neurology. No part of this thesis has formed the basis for the award of any degree previously.

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Dedicated

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Dr. Savi Setia

LIST OF TERMS AND ABBREVIATIONS USED

Seizure: A ‘seizure’ is any sudden event which ‘seizes’ the patient. The term seizure includes epileptic seizures and also other types of non-epileptic episodes as well, e.g. vasovagal faints, episodes due to cardiac problems, non-epileptic attack.

Epileptic seizure: A transient occurrence of signs and/or symptoms due to abnormal excessive or synchronous neuronal activity in the brain.

Epilepsy: A disease characterized by an enduring predisposition to generate seizures; Recurrent (2 or more) epileptic seizures occurring >24 hours apart.

Additional features could be one unprovoked (or reflex) seizure and a probability of further seizures of >60%. Also, where there is a diagnosis of an epilepsy syndrome.

Telemedicine: The remote diagnosis and treatment of patients by means of telecommunications technology.

Smartphone: A mobile phone that performs many of the functions of a computer, typically having a touchscreen interface, Internet access, and an operating system
capable of running downloaded apps.

Squint: Misalingment of the visual axes of the eyes

Cerebral palsy: permanent disorder of movement and posture, causing activity limitation due to nonprogressive damage to the developing brain accompanied by behavioural disturbances and seizures.

Meningeal signs: clinical signs indicating inflammation/ irritation of brain meninges, eg: Neck stiffness, pain on passive extension of flexion of lower limb

OMA: Opsoclonus (Dancing eyes) Myoclonus (muscle jerks of small and large amplitude) ataxia (inability to maintain normal posture

ABBREVIATIONS

AED- Anti Epileptic drugs

BHS- Breath holding spell

BNSM- Benign Neonatal Sleep Myoclonus

CD : Clinical diagnosis

EEG- Electroencephalogram

GTCS- Generalised tonic clonic seizures

HIPAA- Health Insurance Portability and Insurance Act 1996

ILAE – International League Against Epilepsy

NHBI- Neonatal Hypoglycemic brain injury

PNES-Paroxysmal non-epileptic seizures

Public law that standardize electronic exchange, privacy and security transfer across internet platforms

PVL- Periventricular Leukomalacia

SPSS - Statistical Package for Social Science

VD: Video diagnosis

VEM- Video EEG Monitoring

WhatsApp - software modality used by cell-phone users to send messages, images and videos

WHO- World Health Organisation

ABSTRACT

Introduction: Good quality videos of the event (whole or part of it) recorded by a family member or other witness may indirectly provide opportunity for “direct” observation of what had happened. With the ready availability of smart phones in most homes, it has become relatively easier for parents to video record the event and bring it physician’s office.

Aim of the Study:

1. To determine the spectrum of paroxysmal disorders diagnosed with home-videos.
2. To determine the proportion of children in whom the diagnosis of a paroxysmal disorder was confirmed or changed by home-videos.
3. To determine and compare the accuracy of video-diagnosis by experienced pediatrician, adult neurologist and a pediatric neurologist.

Materials & methods:

- Age 0 years to 18 years
- Gender: either
- New onset spell. For children with a known paroxysmal disorder, new type of spells were included in the study
- Availability of home video recorded on smartphone or other devices such as CCTV

At initial encounter, clinical diagnosis was made on the basis of history and physical examination only. Later, the available home video was reviewed and classified by the expert (pediatric neurologist) and differentiated into epileptic and non-epileptic or inconclusive.

Results: After video-review was added to the history and physical examination, Non-epileptic events were diagnosed in 18 (31%) children compared with 10 (17%) a significant increase by 8 cases (13%). Pediatric neurologist has enhanced accuracy of video diagnosis for non-epileptic disorders compared with a pediatrician and an adult neurologist, possibly resulting from enhanced knowledge and experience of dealing with children with paroxysmal disorders

Conclusion: Our study established that home videos are useful to aid differentiation between epileptic and non-epileptic seizures, especially when viewed by a more experienced clinician

Keywords: Epileptic seizures, smartphone videos, clinical & video diagnosis

TABLE OF CONTENTS

S.NO.	TOPIC	PAGES
I	INTRODUCTION	1-4
II	AIMS AND OBJECTIVES	5
III	REVIEW OF LITERATURE	6-13
IV	MATERIALS AND METHODS	14-17
V	OBSERVATIONS AND RESULTS	18-61
VI	DISCUSSION	62-77
VII	LIMITATIONS	78
VIII	SUMMARY AND CONCLUSION	79
IX	FUTURE DIRECTIVES	80
X	BIBLIOGRAPHY	81-84

APPENDICES–I

- PROFORMA
- MASTER CHART

APPENDICES–II

- APPROVAL LETTER OF THESIS PLAN
- THESIS PLAN

LIST OF TABLES

TABLE NO.	TITLE	PAGE NO.
1	ILAE 2017 classification of seizures	6
2	Classification of non-epileptic spells according to age	7
3	Case distribution based on gender	18
4	Age distribution of children with paroxysmal events	19
5	Possible Triggers identified in association with paroxysmal events	20
6	Possible Warning signs associated with paroxysmal events in our study	22
7	Distribution of children based on semiology of paroxysmal event	23
8	Case distribution based on post event details	24
9	Case distribution based on duration of paroxysmal events	25
10	Case distribution based on frequency of events in our study	26
11	Distribution of children based on family history of epilepsy	27
12	Distribution of children based on effect of Perinatal insult leading to paroxysmal event	28
13	Distribution of children based on altered Developmental history	29
14	Physical examination findings in children with paroxysmal events	30
15	Case distribution based on Neurological examination in our study	31
16	Case distribution of children based on EEG abnormalities	32
17	Neuroimaging findings in children with paroxysmal events in our study	33
18	Clinical diagnosis of paroxysmal events in children	35
19	Final diagnosis after history+physical examination+video review	36
20	Distribution of paraoxysmal events into different categories based on History & Physical examination	36

21	Distribution of children based on Video diagnosis by a Pediatrician	37
22	Distribution of events based on Video Diagnosis by pediatrician	38
23	Video diagnosis by adult neurologist	39
24	Distribution of children based on video diagnosis by adult neurologist	40
25	Distribution of children based on video interpretation by Pediatric neurologist	41
26	Distribution of events based on video diagnosis by pediatric neurologist	42
27	Case distribution based on final diagnosis of events	43
28	Distribution of events based on final diagnosis	44
29	Comparison between video-diagnosis by different experts with final diagnosis	45
30	Comparsion data between final diagnosis, age and gender distribution	46
31 A	Comparison data between possible triggers and final diagnosis of paroxysmal events	48
31 B	Distribution of children based on influence of triggering factors on final diagnosis	48
32	Comparison data between nature of paraoxysmal events and final diagnosis	49
33	Comparison between level of consciousness & final diagnosis of the event	50
34 A	Comparison data depicting the observed relationship between post event status and final diagnosis	51
34 B	Comparison data altered mental status and outcome of event	51
35	Comparison data between abnormal neuro examination and outcome of events	53
36	Comparison data between EEG findings and outcome of events	54
37	Comparison between Final diagnosis vs Video diagnosis by Pediatrician	55
38	Bivariate analysis between video diagnosis by adult	56

	neurologist and final diagnosis	
39	Comparison data between Video diagnosis by pediatric neurologist and Final diagnosis	57
40	Bivariate analysis between clinical diagnosis and final diagnosis	58
41	Bivariate analysis between 2 physicians based on video diagnosis	59
42	Bivariate analysis between video diagnosis of 2 physicians	60
43	Analysis between age and final diagnosis	61

LIST OF FIGURES

FIGURE NO.	TITLE	PAGE NO.
1	Pie chart representing gender distribution	18
2	Graphical representation of age wise distribution of paroxysmal events	19
3	Clustered Bar depicts case distribution based on triggering factors associated with paraoxysmal events	21
4	3D column depicting distribution of cases based on warning signs associated with paraoxysmal events.	22
5	3D Column representing % distribution of children with Post event changes in sensorium or motor component	24
6	Distribution of children based on duration of event in our study	25
7	Clustered columns showing % of children with differential frequency of events in our study	26
8	Pie chart depicting percentage of children with positive family history	27
9	Pie chart depicting % of children with Abnormal birth history	28
10	Pie chart representing % of children with Delayed Devlopment	29
11	Pie chart depicting Abnormal physical examination findings in children	30
12	Clustered Bar depicting children with Abnormal neurological examination	31
13	Clustered Column depicting EEG abnormalities found in children during our study	32
14	Pie chart depicting % distribution of children with Abnormal Neuroimaging	34
15	Columns depicting differentiation of events based on clinical diagnosis	35
16	Pie chart depicting % distribution of children based on video diagnosis by pediatrician	37

17	3D Columns depicting differentiation of events by adult neurologist	39
18	Pie chart depicting % distribution of children with paraoxysmal events based on Video diagnosis by Pediatric neurologist	41
19	Bar graph showing % distribution of children into epileptic and non epileptic based on final diagnosis	43
20	Clustered Columns and Lines depicting relationship between age, gender and final diagnosis	47
21	3D Column graphics depicting effect of loss of awareness with final diagnosis	50
22	Comparison data between Post event status and final diagnosis of paroxysmal events	52

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INTRODUCTION

A spell or paroxysm is an event, episode, or attack. In neurological context, a spell refers to episodic neurological symptoms that arise from transient changes in motor, sensory, autonomic and cognitive functions of the body. The terms ‘paroxysm’ and ‘ictus’ are also sometimes used to denote the same. In reality, all these terms (spell, paroxysm, event, attack, and episode) have been interchangeably used in the medical literature. The disorders which present in this way are called paroxysmal disorders. [1,2]

Broadly, spells are divided into two types: seizures (epileptic spells) and non-seizure or (non-epileptic spells).[3,4] Seizures or epileptic spells result from abnormal and excessive neuronal discharge in the cerebral cortex and therefore have electroencephalographic (EEG) correlates. All other paroxysmal events that are not seizures, are included under the umbrella term of non-epileptic spells (NES), also called non-epileptic events (NEE), non-epileptic paroxysmal disorders (NEPD), paroxysmal non-epileptic disorders (PNED), paroxysmal non-epileptic events (PNEE), imitators of epilepsy or simply seizure mimics.[4-7] The non-epileptic spells have an outward semiological resemblance with seizures but unlike seizures, are not caused by abnormal excessive discharge of cortical neurons, and therefore are without any EEG corelates. Pathophysiological alterations involved in the occurrence of non-epileptic spells are varied and can arise within as well as outside the nervous system.[1,8,9] Seizures and epilepsies are further classified according to the well-known systems of classification of seizures and epilepsies by International League against Epilepsy (ILAE).[10,11] On the other hand, non-epileptic spells in children have been classified variously according to the age of onset, pathophysiology, mode of presentation and whether occurring during wakefulness or sleep.[12]

Paroxysmal disorders are a common occurrence in children at all ages from the neonatal period to the adolescence.[1,6,13,14] Non-epileptic spells are much more common than epileptic spells. While incidence of

epilepsy has been assessed at 50.4 per 100,000 per year,[15] Similar studies to ascertain the incidence of non-epileptic spells in children are not available. A prospective study that included children upto 1 year of age, found the incidence of paroxysmal disorders between 8.9% to 12.9%, and epilepsy accounted for a very small fraction.[2] In another prospective study, paroxysmal events occurred in 25% of children up to 2 years of age. [16]

Similar to epileptic seizures, non-epileptic events also involve intermittent and transient stereotyped alteration in cognitive, motor, sensory, autonomic or psychic behavior.[2] It is, therefore, not surprising that non-epileptic spells seemingly have an outward resemblance with epileptic seizures and are therefore, frequently misdiagnosed as epilepsy resulting in unnecessary and potentially harmful diagnostic and therapeutic interventions, as it may take years before correct diagnosis is discovered.[4] Misdiagnosis also carries the risk of overlooking potentially life threatening but treatable non-epileptic conditions such as prolonged QT syndromes**.** [7] What is alarming is that the magnitude of this problem of misdiagnosis is not insignificant.[17] Equally important but less prevalent than misdiagnosis of epilepsy is the problem of missed diagnosis of epilepsy.[5] This may lead to false assurance that patient does not have epilepsy, and the child deprived of effective antiepileptic medications and exposed to risk of having more seizures. Wrong diagnosis may also initiate a cascade of inappropriate investigations and therapeutic interventions with potential for bodily and psychological harm. It is, therefore, of utmost importance to carefully evaluate, investigate, diagnose, differentiate, and treat paroxysmal events in children to minimize the diagnostic errors and therapeutic misadventures.[12]

History (description of the event) furnished by the patient and/or the witness is the most important, and often the only evidence available to the physician to arrive at a diagnosis. Paroxysmal events are transient phenomena that rarely occur in physician’s office, and almost always have no ‘inter-ictal’ signs on neurological examination. Even if physical

and neurological signs are present, they general point to the underlying disorder, and never to the nature of paroxysmal event. Laboratory investigations are helpful only when guided by a strong clinical suspicion. Video-EEG is the gold standard of evaluation of paroxysmal disorders, but facilities for such an intervention are not easily available in countries like ours. Moreover, video-EEG may not be useful when events are infrequent. As a result, often, it becomes difficulty to reliably distinguish between the different types of events, resulting in (mis) diagnosis with non-seizure events being diagnosed as seizures and vice versa. Studies suggest that up to 30% of patients presenting with “epilepsy” may not have epilepsy. [3,18,19] Similar percentage of patients presenting to refractory epilepsy clinics have been found to have non-epileptic spells.

Other than and in the absence of video-EEG availability, Observing of the event by the physician is the single most valuable clinical tool which not only help in identifying seizure from non-seizure events but also allows further characterization of individual events. Unfortunately, because of their nature, the paroxysmal events are rarely seen by the physician in the clinic. Good quality videos of the event (whole or part of it) recorded by a family member or other witness may indirectly provide opportunity for “direct” observation of what had happened. With the ready availability of smart phones in most homes, it has become relatively easier for parents to video record the event (whole or part of it) and bring it physician’s office. Many non-epileptic paroxysmal disorders such as jitteriness and benign neonatal sleep myoclonus in the neonates, shuddering episodes in infants, gratification phenomenon in young children etc., are easily recognized on viewing the video, thus obviating the need for costly diagnostic and therapeutic interventions. Smart phones offer an easily available, cheap and handy tool to record these episodes providing a permanent record of the events which can be viewed and reviewed as many times as necessary, and also allows sharing with experts for opinion as and when indicated.

There has been recent interest on the clinical utility of smart phones in the diagnosis and differential diagnosis of both epileptic and non-epileptic disorders. Several recent studies suggest smart phone videos as a useful adjunctive tool in the diagnosis of seizure, and non-seizure events. Dash and colleagues collected analyzed 624 seizures from home videos collected from 312 patients. Home videos were more reliable in picking up semiological signs and classifying epilepsy type than history provided by caregivers. Authors suggested that home videos were a complementary tool in a developing country like India.[20] Beniczky et al. compared the interpretation of seizures from clinical description with that inferred from video recordings. Video recordings significantly increased the accuracy of seizure interpretation.[21] Another study of prospectively collected smartphone videos from patients who presented to an epilepsy center compared the video-based diagnosis with the eventual diagnosis based on video-EEG. Authors concluded that Smartphone video interpretation can be a useful adjunctive tool in the diagnosis of seizure-like events.[22] A recent systematic review of 17 studies on the clinical utility of home videos for diagnosing epileptic seizures concluded that home video recordings being low cost and widespread availability can be of diagnostic value in the diagnosis and management.[23]

Current study was done to evaluate the utility of smart phone videos of the events recorded at home by the parents or caregiver in the diagnosis of epileptic and non-epileptic paroxysmal disorders and better differentiation between the 2 in children in the setting of a developing country.

AIMS AND OBJECTIVES

1. To determine the spectrum of paroxysmal disorders diagnosed with home-videos.
2. To determine the proportion of children in whom the diagnosis of a paroxysmal disorder was confirmed or changed by home-videos.
3. To determine and compare the accuracy of video-diagnosis by experienced pediatrician, adult neurologist and a pediatric neurologist

REVIEW OF LITERATURE

Presentation with paroxysmal events is one of the most common clinical scenario in the pediatric out-patient settings. Though parents might be worried about the epileptic nature of the spells, physicians have to keep the possibility of non-epileptic mimics of seizures in the differential diagnosis. Each type of spell whether epileptic or non-epileptic requires further characterization into specific subtypes. Epileptic events (seizures) are classified and subclassified according to ILAE system of classification of seizures ad epilepsies (Table 1). Non-epileptic spells, on the other hand have been classified or subclassified in several ways though aged based classification is most common and most useful clinically (Table 2).

Table 1. ILAE 2017 classification of seizures

<table>
<tr><th colspan="2">Focal Onset</th><th>Generalised Onset</th><th>Unknown Onset</th></tr>
<tr><td>Aware</td><td>Impaired awareness</td><td rowspan="3">Motor
Tonic-clonic
Clonic
Tonic
Myoclonic
Myoclonic-tonic-clonic
Myoclonic-atonic
Atonic
Epileptic spasms
Nonmotor (absence)
Typical
Atypical
Myoclonic
Eyelid myoclonia</td><td rowspan="3">Motor
Tonic-clonic
Epileptic spasms
Nonmotor
Behavior arrest
Unclassified</td></tr>
<tr><td colspan="2">Motor onset
Automatism
Atonic
Clonic
Epileptic spasms
Hyperkinetic
Myoclonic
Tonic</td></tr>
<tr><td colspan="2">Nonmotor onset
Autonomic
Behavior arrest
Cognitive
Emotional
Sensory</td></tr>
</table>

Table 2: Classification of non-epileptic spells according to age*

Neonates	Older children
Jitteriness Benign Neonatal Sleep Myoclonus Apnea episodes Hyperekplexia Subtle phenomena Hiccups Opisthotonus Pathological myoclonus Apparent life- threatening events (ALTE)	Parasomnia: Nightmares, sleep terrors Migraine Migraine variants: Cyclic vomiting syndrome Abdominal migraine Paroxysmal movement disorders Stereotypies Withholding, constipation Drug reactions
Infants/young children	**Adolescents**
Breath-holding spells Benign myoclonus of infancy Shuddering episodes Gratification Migraine variants Benign paroxysmal vertigo Benign paroxysmal torticollis Benign tonic upward gazing Spasmus nutans Sandifer syndrome Stereotypies Head rolling/banging Withholding, constipation Hyperekplexia	Syncope Migraine and variants Psychogenic non-epileptic spells Malingering Panic attacks Hyperventilation syndrome Paroxysmal movement disorders Paroxysmal pain syndromes Sleep disorders Hypnic jerks/sleep starts Sleep myoclonus Narcolepsy Sleep walking, sleep talking Parasomnia

*, The list of examples is not exhaustive

Detailed comprehensive clinical history of the events obtained from the eyewitnesses or care giver is the most important tool in the hands of a physician while approaching a child with spells. Physical examination seldom adds to the diagnosis as most of the children have normal findings in the interictal period. It is also not very common for the events to occur during the clinical encounter. As a result, physicians have to rely heavily on the historical information for initial diagnostic impressions and as a guide for further investigations. Incomplete history, often a consequence of time constraints is cited as the single most important cause of diagnostic inaccuracies. Routine interictal EEG is also not helpful in discriminating epileptic from non-epileptic spells. Video-EEG is the gold standard, but not easily available. In the absence of video-EEG equipment availability, home video recording of the events could possibly increase the diagnostic accuracy by providing the “visual action-replay” of the spells. Prior to the emergence of smart phones, clinicians and parents employed other forms of video-recording equipment to capture the events at home. With the advent and advancement of the smart phone technology which has made mobile telephony ubiquitous and a common household and portable (personal) gadget, there has been rise in the use of home videos in recording the events by the caregiver. Smart phones are easy to operate (require little if any training) and have capabilities to capture detailed motor and other behaviors. The literature on the subject is very recent and several studies attest to their usefulness in the diagnosis and differential diagnosis of both epileptic and non-epileptic events, importance of which can never be over emphasized.

Amin et al. (2021) [22] prospectively compared the diagnosis based on smartphone videos to the final diagnosis based on standard video-EEG monitoring. Of the 54 adult patients (mean age 34.7 years) included in the study, 36 had conclusive data (both on smart phone videos and video-EEG monitoring), and 18 nonconclusive. Mobile phone video and video-EEG were in agreement in 34 (94%). Of these, 13 had epileptic and 23 non-epileptic spells. Authors concluded that interpretable home-

recorded smartphone videos were helpful adjunctive tool in the diagnosis of seizure-like events.[18]

Gowda and colleagues (2019) [24] from South India prospectively studied nonepileptic events in children up to 18 years of age. A total of 3660 children presented with paroxysmal events, out of which 285 (8%) had non-epileptic events. Age at presentation ranged from 1 to 185 months (mean age 77.31 months). There were with 66 boys and 45 girls. Home videos were found to be useful in the diagnosis of specific non-epileptic events in 35% children.[19]

Huang et al. (2019) [25], from China investigated the role of smart phone videos in enhancing the diagnostic accuracy and as a result cost savings of paroxysmal events in infants. They asked 452 practitioners to diagnose paroxysmal events from the clinical descriptions and home video in 12 infants. The mean correct diagnoses with videos were 8.4 (SD 1.7) of 12 and without videos 7.5 (SD 1.7) of 12. For seizures, mobile phone videos increased the mean accurate diagnoses by 3.9% and 11.5% for nonepileptic events. The results were statistically significant. Pediatric neurologists with longer experience had higher diagnostic accuracy. There was significant cost saving. The authors concluded that home videos made on mobile phones were a cost-effective tool for the diagnosis of paroxysmal events in infants.

In another prospective and masked study, Tatum et al [26] collected a convenience sample of 44 smartphone videos from outpatient patients. These patients were formally investigated with video EEG telemetry to definitively confirm whether the events were epileptic or non-epileptic seizures. A study group of 530 epileptologists and trainees blinded to the diagnosis were shown the videos. About 80% of recorded videos were ranked by reviewers as having adequately good quality. Smartphone video was accurate in predicting diagnosis of epileptic seizures by experts 89.1% (95% CI, 84.2%-92.9%) of the time, with a specificity of 93.3% (95% CI, 88.3%-96.6%). Resident responses less accurate, despite greater confidence. Motor signs during events

increased accuracy. Addition of history and examination to video, diagnoses rose from 78.6% to 95.2%. A correct diagnosis was 5.45 times greater when smartphone video accompanied history and examination (95% CI, 1.01- 54.3; P = 0.02). The authors concluded that outpatient smartphone video review by experts had predictive and additive value for diagnosing epileptic seizures.

Ramanujam et al. (2018) [27] assessed the contribution of home-videos to diagnosing psychogenic nonepileptic seizures (PNES). Caregivers of consecutive patients (N=783) attending a neurology service between 10 and 50 years of age were invited to make home recordings of their events. Of this group 269 videos were considered of fair or good quality and included. Videos of all recruited subjects were reviewed by the epilepsy fellow blinded to clinical history (step 1). All patients subsequently underwent vEEG which were reviewed by an epileptologist blinded to the diagnosis formulated by the epilepsy fellow (step 2). The diagnosis at step 1 was epileptic seizures in 71.4% and PNES in 27.1%. Diagnosis at step 2 was epileptic seizures in 73.6% and PNES in 25.3%, other physiologic events in less than 1% and There was a concordance between the diagnoses in steps 1 and 2 of 97.2% of subjects with no statistically significant difference between the diagnoses of steps 1 and 2. The most commonly noted semiological features on home videos pointing to diagnosis of PNES were, eye closure; accuracy of 96.2% (95% CI: 92.3%-98.45%) Crying or shouting; accuracy of 89.6% (95% CI: 83.1%- 93.2%) Hyperventilating; accuracy 89.1% (95% CI: 83.7%- 93.2%) Wild, uncoordinated movements; accuracy 71.74% (95% CI: 64.6%-75.7%) Lying still/no movements; accuracy 81.6% (95% CI: 75.3%-86.8%). The study authors concluded that good quality home-videos were likely useful to differentiate PNES from epileptic seizures and can complement vEEG in diagnosing PNES in a cost effective way.

Wasserman *et al (2017)* recruited [28] 46 clinicians consisting of 20 neurologists and 26 non-neurologists, and showed them 10 videos (5 psychogenic non-epileptic seizures and 5 epileptic seizures). Epilepsy

experts diagnosed 87.5% of cases correctly, neurologists upto 72.8%. Neurology nurses made a correct diagnosis upto 69.8%, Internal medicine experts 54.1% and Emergency physicians upto 44.4%. Statistical significant difference between the general physicians to all neurology group professions was >0.05. Clinicians with neurology training were statistically more likely to recognise seizures through the semiology viewed on the videos than the general physicians.

Ojeda et al (2016) [29] consecutively invited caregivers of adult patients attending an epilepsy clinic to record home videos of events. These were assessed by three neurologists and epileptologists who attempted to differentiate if events were epileptic or not. They then reviewed the patients at a later point with the addition of other information including history and investigations, to assess if the original diagnosis changed. Fifty percent of the patient's caregivers elected not to be part of the study citing that it would be too challenging to capture an event. From the original 317 patients, after recruitment completed and only viable videos were included, the group had 50 videos from 22 patients to analyse. The study concluded that homemade videos might be of diagnostic value in epilepsy management.

Dash et al (2016) [20] studied the yield of semiological features from home recorded videos and compared them with information obtained from clinical history in epileptic patients in the setting of a developing country (India). Mean age of the patients was 26.76 years ± 7.5 years. Home videos were available for 312 patients. Home videos detected significantly more semiological signs than the history alone. A large number of patients were correctly categorized into the focal epilepsy group from home recorded videos as compared to when only history was used. Videos which included bilateral generalized clonic movements of limbs, movement around mouth, fear, visual disturbances, hemisensory phenomena, and post-ictal asymmetrical weakness found the highest accuracy. The authors concluded that in persons with epilepsy, home recorded videos were found to be more reliable in detecting semiological signs and classifying spell type than

the history alone provided by caregivers. In a developing country like India, home videos could be an important complementary tool for accurate semiological classification of epileptic seizures.

Goodwin *et al* [30] recruited a group of 45 patients (adults and children) who were undergoing ambulatory EEG and asked caregivers to simultaneously record the video events. There was good correlation with the adequate videos aiding the ambulatory EEG analysis. Thirty-four (76%) had an event of which 17 (50%) were adequately/satisfactorily recorded. Attacks were captured with greater success in children (14/23, 61%) than adults (3/11, 27%). Of the 17 video recordings, 14 (82%) aided interpretation of the ambulatory EEG. The main reasons for failure were that attacks were too brief, or machine error. Whilst the video enhanced the analysis in a proportion of the patients, there were significant challenges illustrated with the ability to capture the events.

Samuel and Duncan [31] used a portable video recorder to record events from 22 patients with undiagnosed seizures. The video recordings assisted the diagnosis of non-epileptic attacks in 9 of 22 patients (41%), and of epileptic events in 8 of 22 patients (36%). 5 patients (23%) paroxysmal activity could not be recorded as three of whom had seizures that were too short to be recorded. In 2 patients (9%) a diagnosis of non-epileptic seizures could be made from the videotapes alone. 7 patients required video-EEG recording. It was found that the pocket video camera was a useful and inexpensive tool to provide accurate seizure description but should be used in combination with other evidence to classify seizures. Interactions with patient during recording were also observed to be particularly helpful.

In a recent systemic review, Ricci and colleagues [23] analyzed 32 published reports about the use of home videos in the differential diagnosis of paroxysmal seizure like episodes. Seventeen studies were included in the review. All studies reported enhanced diagnostic and clinical decision-making. One study found that Home video recordings

decreased the stress level in many families and improved their quality of life. The authors concluded that home videos provided diagnostic value in epilepsy diagnosis and management.

MATERIALS AND METHODS

Study site: The study was carried out in the Outpatient Neurology clinic in the Department of Pediatrics, Dayanand Medical College and Hospital, Ludhiana

Choice of Subjects: Paroxysmal disorder was defined as any episode of neurological symptoms characterized by transient alteration in motor, sensory, autonomic, cognitive, or psychic behavior.

All children with new-onset spells were included.
Both epileptic and non-epileptic events were included.
Following inclusion and exclusion criteria were employed:

Inclusion Criteria:

- Age 0 years to 18 years
- Gender: either
- New onset spell. For children with a known paroxysmal disorder, new type of spells were included in the study
- Availability of home video recorded on smartphone or other devices such as CCTV

Exclusion Criteria

- No home video available
- Available video is of poor quality
- Parents' refusal to participate.

The selected children meeting the inclusion criteria had to undergo detailed clinical evaluation by history and physical examination. Laboratory investigations will be dictated by clinical suspicion of the underlying cause of spells. Similarly, neuroimaging and electroencephalography (EEG) was done on the basis of results of clinical evaluation.

Methodology: The selected children meeting the inclusion criteria underwent detailed clinical evaluation by history and physical examination. Laboratory investigations were dictated by clinical suspicion of the underlying cause of spells. Similarly, neuroimaging and electroencephalography (EEG) was done on the basis of results of clinical evaluation.

At initial encounter, clinical diagnosis was made on the basis of history and physical examination only. Later, the available home video was reviewed and classified by the expert (pediatric neurologist) and differentiated into epileptic and non-epileptic or inconclusive. Wherever possible subtypes of individual epileptic and non-epileptic events was done to the extent possible. Video diagnosis was then compared with final diagnosis based on clinical history, physical examination, relevant investigations and home video.

Home videos were also independently reviewed by a pediatrician and an adult neurologist, both with more than 15 years of experience in the respective fields. They were blind to the clinical history or diagnosis. They were asked to categorize the given event into epileptic and non-epileptic type. In case of epileptic events, further classification such as generalized or focal, and subtypes such as clonic, tonic, myoclonic etc, to the extent possible was sought. In cases of non-epileptic events, specific diagnosis where possible was sought from them. We compared the accuracy of video diagnosis by a general pediatrician, adult neurologist and compared it with that of a pediatric neurologist.

SOURCE OF DATA

Children attending the pediatric outpatient were the source of data. All children with seizures or seizure-like presentation underwent detailed historical interrogation and physical examination to determine the nature of episodes.

METHOD OF COLLECTION OF DATA

Data was prospectively collected on a pre-structured proforma

DURATION OF STUDY: October 2022- October 2023

CONSENT: obtained as appropriate.

OUTCOME: The use of home videos in diagnosing paroxysmal events in children has yielded several significant outcomes:

1.Enhanced diagnostic accuracy: Home video recordings provided with real-time visual evidence of events, aiding in distinguishing between epileptic seizures and non-epileptic events, and confirming or refuting clinical suspicion, resulting in enhanced confidence of clinical diagnosis.

2.Reduced Misdiagnosis: Videos helped reduce the rates of misdiagnosis by offering clear, observable events that could be reviewed multiple times, allowing for a more accurate assessment.

3.Resource Utilization: Utilizing home videos could reduce the need for expensive and invasive diagnostic procedures, including prolonged EEG monitoring in a hospital setting. Even need for routine EEG and neuroimaging examinations was curtailed.

4.Enhanced communication: Video evidence facilitated better communication between the physician and family, as parents felt confident as to whatever they wanted to communicate was communicated. Some parents might not be able to describe whatever they had observed. In certain cases, parents are overwhelmed by the panic of something unforeseen and catastrophic happening to their child, and are unable to remember the actual event

5. Timely intervention: Early and accurate diagnosis through video recordings enables timely intervention and treatment, which is crucial for the child's overall prognosis and quality of life.

6.Educational value: Home videos serve as valuable educational tools for medical trainees and practitioners, enhancing their ability to recognize and diagnose various paroxysmal events.

STATISTICAL ANALYSIS:- Data was described in terms of range; mean ± standard deviation (± SD), median, frequencies (number of cases) and relative frequencies (percentages) as appropriate. To determine whether the data is normally distributed, a Kolmogorov-Smirnov test was used. Comparison of quantitative variables between the study groups was done using Student t-test and Mann Whitney U test for independent samples for parametric and non-parametric data respectively. For comparing categorical data, Chi square ($\chi 2$) test was performed and fisher exact test was used when the expected frequency was less than 5. A probability value (p value) less than 0.05 was considered statistically significant. All statistical calculations were done using (Statistical Package for the Social Science) SPSS 21 version (SPSS Inc., Chicago, IL, USA) statistical program for Microsoft Windows.

OBSERVATIONS & RESULTS

A total of 65 children were enrolled in our study. Seven children were excluded as their caregivers refused to share video recordings.

GENDER DISTRIBUTION OF CASES

Of the 58 children included in the final analysis, there were 38 (65.5%) boys and 20 (34.5%) girls with male: female ratio of 1.9:1.

Table 3: Case distribution based on gender

Gender	No. of cases	Percentage
Female	20	34.5%
Male	38	65.5%
Total	58	100.0%

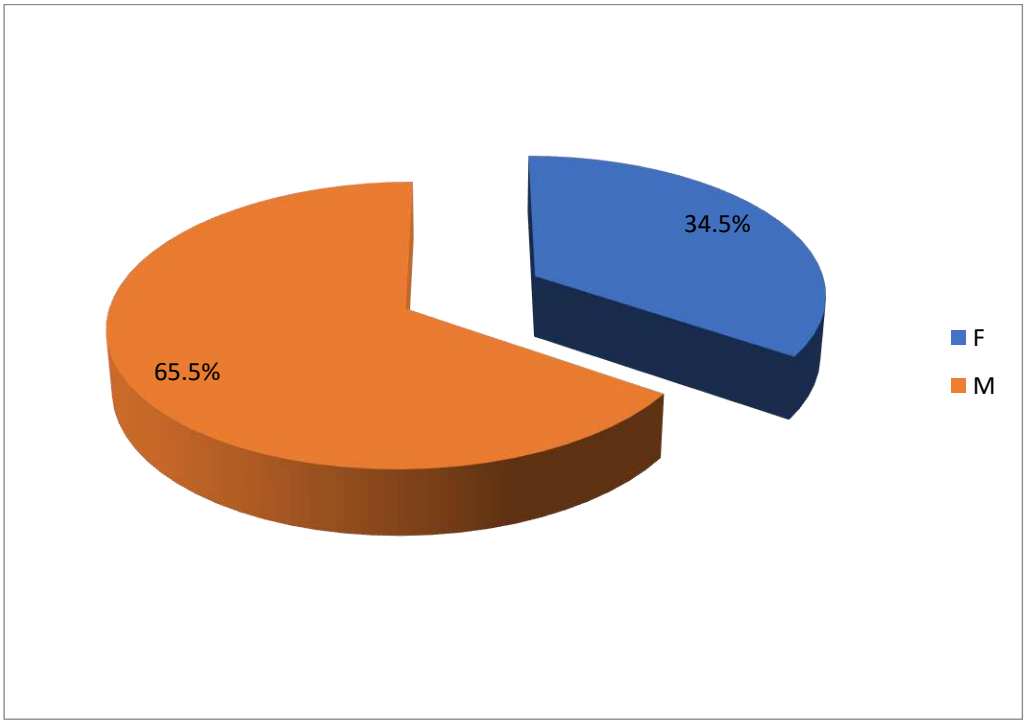

Figure 1: Pie chart representing gender distribution

AGE DISTRIBUTION

Age distribution of the children included in the study is depicted in Table 4 and figure 2. Mean age was 13.85 ±16.32 years (ranging between 7 months to 9 years) There was 1 child (1.7%) <1 month old. Thirteen (22.4%) children were aged between 1 month and 6 months, 9 (15.5%) between 6 months to 1 year, 18 (31%) between 1 year to 5 years, and 13 (22.4%) between 6-9 years. Only 4 (5.8%) children were older than 10 years of age. Majority of the children were aged 5 years or younger, accounting for 42/58 (72.4%), with about a third being 1-5 years of age.

Table 4: Age distribution of children with paroxysmal events

AGE	No. of cases	Percentage
<1 month	1	1.7%
1-6 months	13	22.4%
>6 months - 1 year	9	15.5%
1-5 years	18	31.0%
6-9 years	13	22.4%
>10 years	4	5.8%

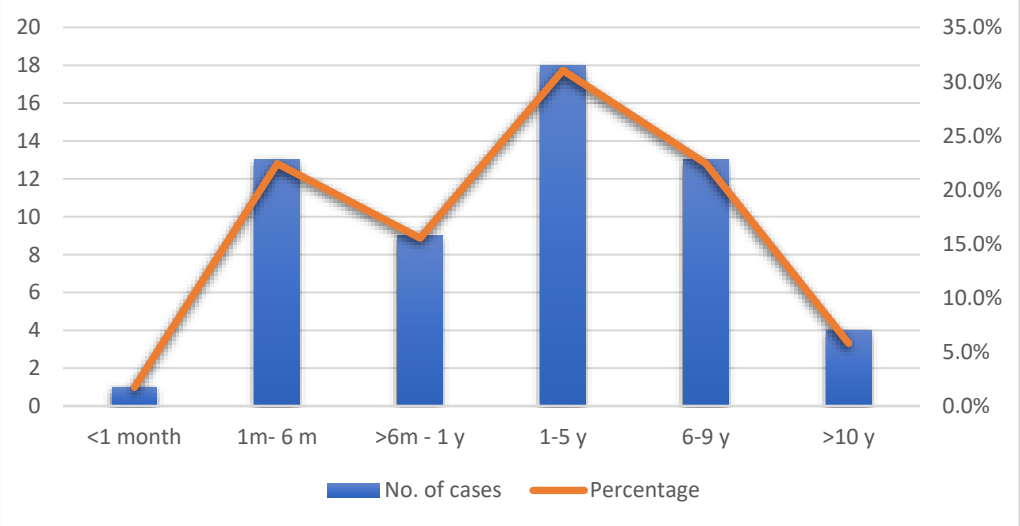

Figure 2: Graphical representation of age wise distribution of paroxysmal events

CIRCUMSTANCES OF OCCURRENCE OF EVENTS

Events were sudden onset in 39 (67.2%) cases while insidious onset of events was noted in 19 (32.8%). Majority of the events were observed at home in 56 children. In 15 children, events occurred exclusively in school. In 47 children, events also occurred at places other than home and school, such as while travelling, while playing outdoors. Events occurred only during sleep in 22 cases while 54 children had events during wakefulness, with overlap in 4 children.

TRIGGERING FACTORS AND WARNING SIGNS ASSOCIATED WITH PARAOXYSMAL EVENTS:

A trigger for the paroxysmal event was identified by parents in 20 (34.5%) cases (Table 5). No trigger was identified in 38 (65.5%) children. Possible triggers were sleep deprivation in 9, emotional upset in 4, and fever, crying, meals, and hyperventilation in 1 each. Stress was identified as trigger in 2 children.

Table 5: Possible Triggers identified in association with paroxysmal events

Triggers	No. of cases	Percentage
No trigger	38	65.5%
Triggers	20	34.5%
Sleep deprivation	9	15.5%
Emotional upset	4	6.9%
Stress	2	3.4%
Fever	1	1.7%
Hyperventilation	1	1.7%
Crying	1	1.7%
Meals	1	1.7%
Miscellaneous	1	1.7%
Total	58	100.0%

Figure 3: Clustered Bar depicts case distribution based on triggering factors associated with paraoxysmal events

Table 6: Possible Warning signs associated with paroxysmal events in our study

Warning sign	No. of cases	Percentage
Absent	44	75.9%
Present	14	24.1%
Vacant stare	5	8.6%
Irritable	3	5.2%
isolates himself	1	1.7%
Throws self to ground	1	1.7%
Pain abdomen	1	1.7%
Tickling	1	1.7%
Hyperventilation	1	1.7%
Visual aura	1	1.7%
Total	58	100.0%

In 44 cases, no warning signs associated with the event was identified. Of the 14 children with warning signs, vacant stare and irritability preceded the actual event in 5 and 3 cases respectively. Other warning signs are depicted in the **table 6.**

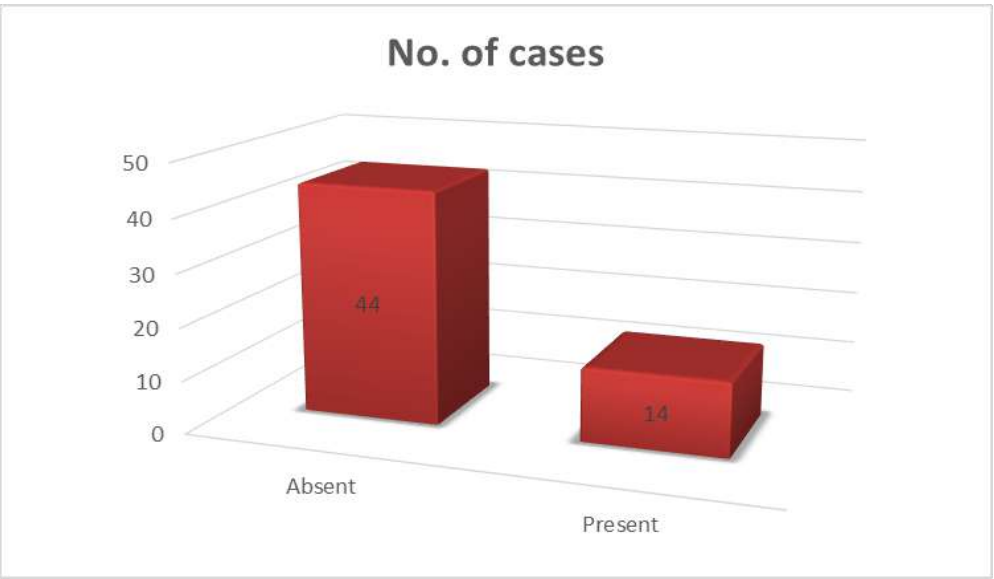

Figure 4: 3D column depicting distribution of cases based on warning signs associated with paraoxysmal events.

SEMIOLOGY OF EVENTS:

Uprolling of eyes during the events was noted in 23 cases.

There were 46 cases (79.3% cases) who had symmetrical movements of all limbs during the events whereas 11 (19%) cases had asymmetric movements of limbs during the event.

Nineteen cases (32.8%) had experienced stiffness for variable duration during the event.

Clonic movements were observed in 29 cases (50%).

Out of 58 cases, 16 children had focal activity of limbs contributing upto 27.6% of cases whereas 42 cases had generalised movements of all limbs contributing 72.4% of total cases.

Out of 58 cases, 21 (36.2%) children maintained awareness, whereas 37 (63.8%) children had impaired awareness during the event.

Table 7: Distribution of children based on semiology of paroxysmal event

Semiology	No. of cases	Percentage
Uprolled eyes	23	39.7%
Bilaterally symmetrical	46	79.3%
Body Stiffening	19	32.8%
Clonic movements	29	50.0%
Generalised activity	42	72.4%
Impaired awareness	21	36.2%

CASE DISTRIBUTION BASED ON POST EVENT DETAILS

Table 8: Case distribution based on post event details

post event	No. of cases	Percentage
Normal	18	31.0%
Abnormal	40	69.0%
Lethargy	15	25.9%
Cry	11	19.0%
sleeps	7	12.1%
Cyanosed	2	3.4%
Limb Weakness	1	1.7%
Miscellaneous	4	6.9%
Total	58	100.0%

We found that 18 cases (31%) of total had no change in their mental status whereas there were 15 who complained of lethargy and 11 children who had started crying followed by 7 who slept post event, thus indicating epileptic nature of the event. Although all of these children were not found to have experienced epileptic events later on

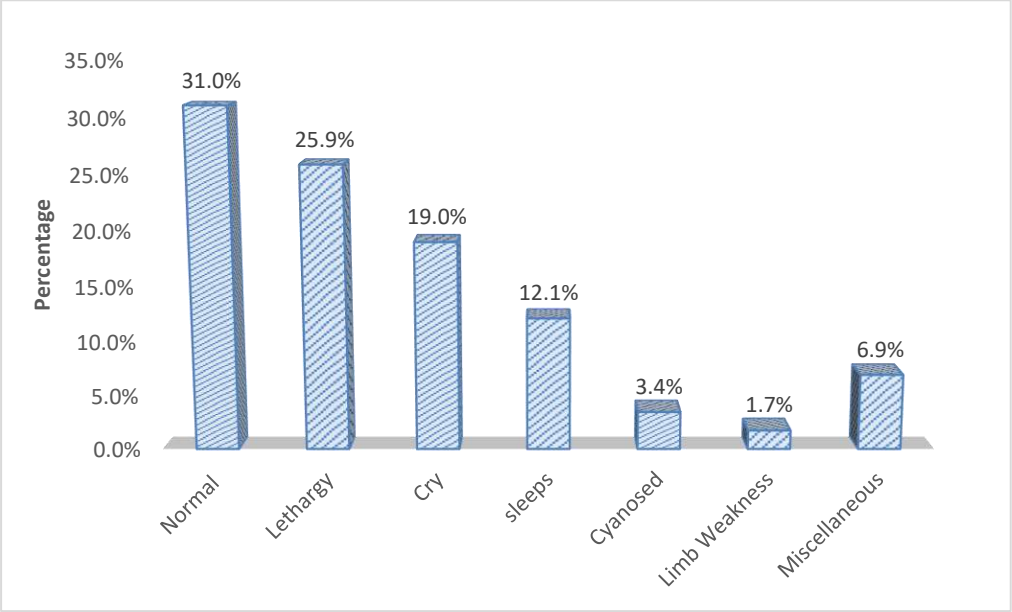

Figure 5: 3D Column representing % distribution of children with Post event changes in sensorium or motor component

CASE DISTRIBUTION BASED ON DURATION OF THE EVENT

Table 9: Case distribution based on duration of paroxysmal events

Duration of paroxysmal event (minutes)	No. of cases	Percentage
< 1	33	56.9%
1-5	18	31%
5-10	5	8.6%
>10	2	3.4%
Total	58	100.0%

In Majority (56.9%) of the children, the event lasted <1 minute, followed by 1-5 minutes in 18 children (31%) and 5-10 minutes in 5 children (8.6%). Only 2 children had events lasting > 10 minutes.

We could not comment upon the nature of the events whether they were epileptic or non-epileptic based on duration of events.

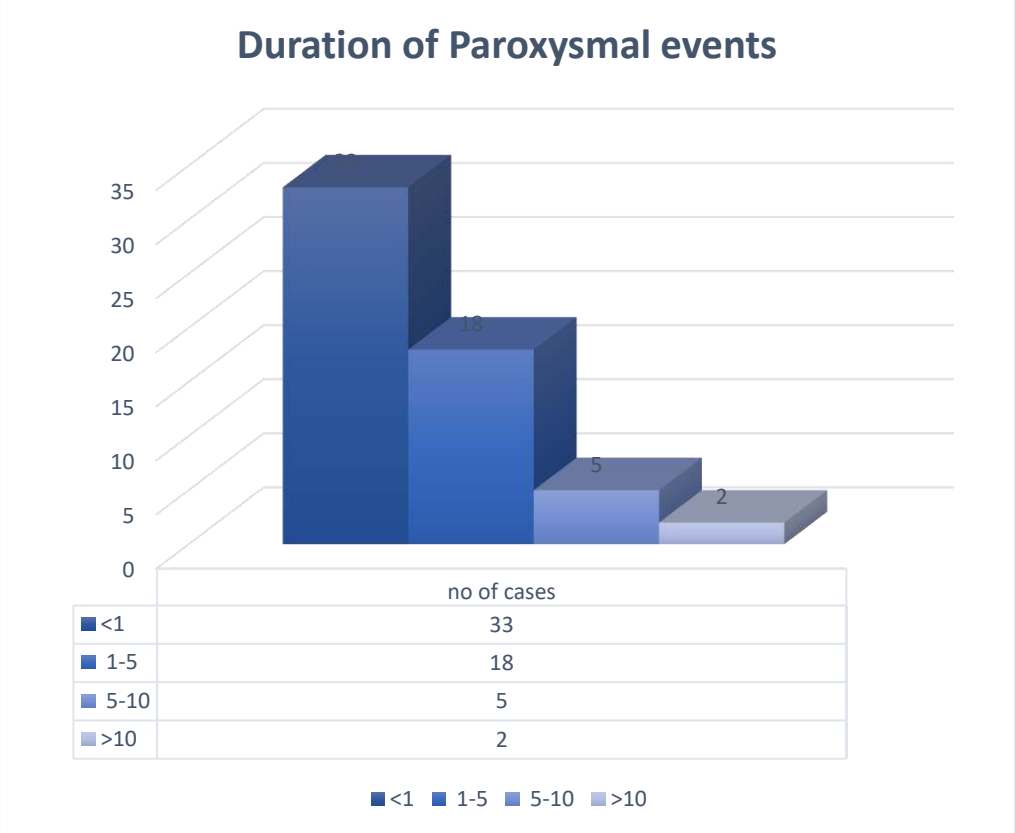

Figure 6: Distribution of children based on duration of event in our study

CASE DISTRIBUTION BASED ON FREQUENCY OF EVENT

Majority of the children had daily spells which varied from 1-25 per day. Two children had weekly spells. One child had monthly spells. In 5 children, frequency was less than 1/month.

Table 10: Case distribution based on frequency of events in our study

Frequency of paroxysmal events	No. of cases	Percentage
1-25/ day	54	93%
1/ week	2	3.4%
1/ month	1	1.7%
<1/ month	1	1.7%
Total	58	100.0%

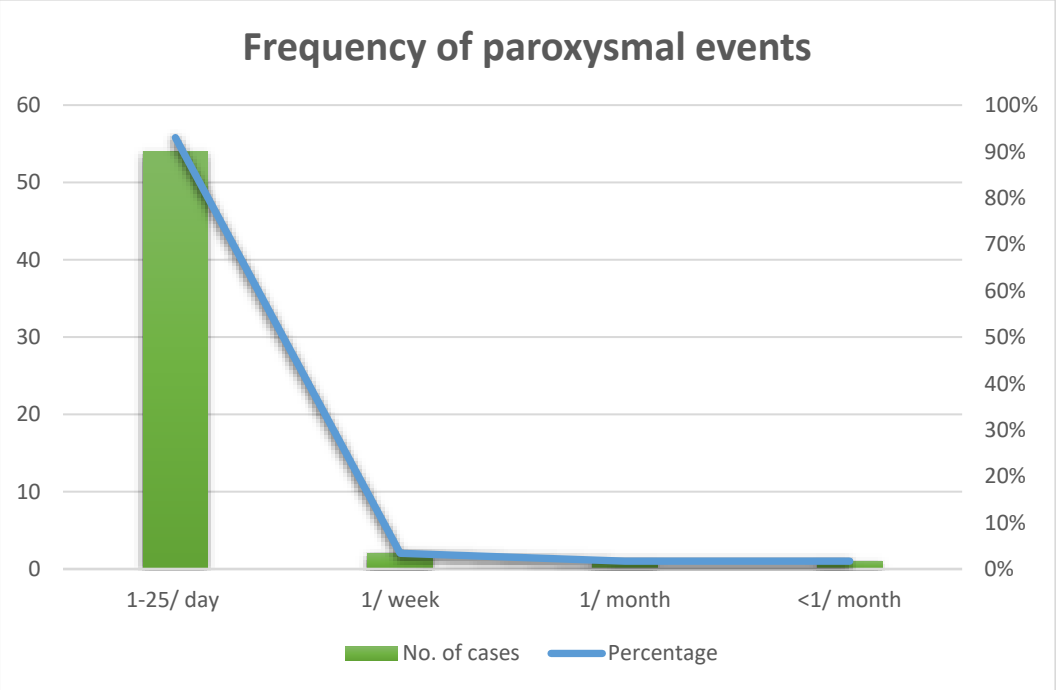

Figure 7: Clustered columns showing % of children with differential frequency of events in our study

FAMILY HISTORY: 5 children (8.6%) had family history of epilepsy whereas 53 children had No significant family history.

Table 11: Distribution of children based on family history of epilepsy

Family h/o epilepsy	No. of cases	Percentage
No	53	91.4%
Yes	5	8.6%
Total	58	100.0%

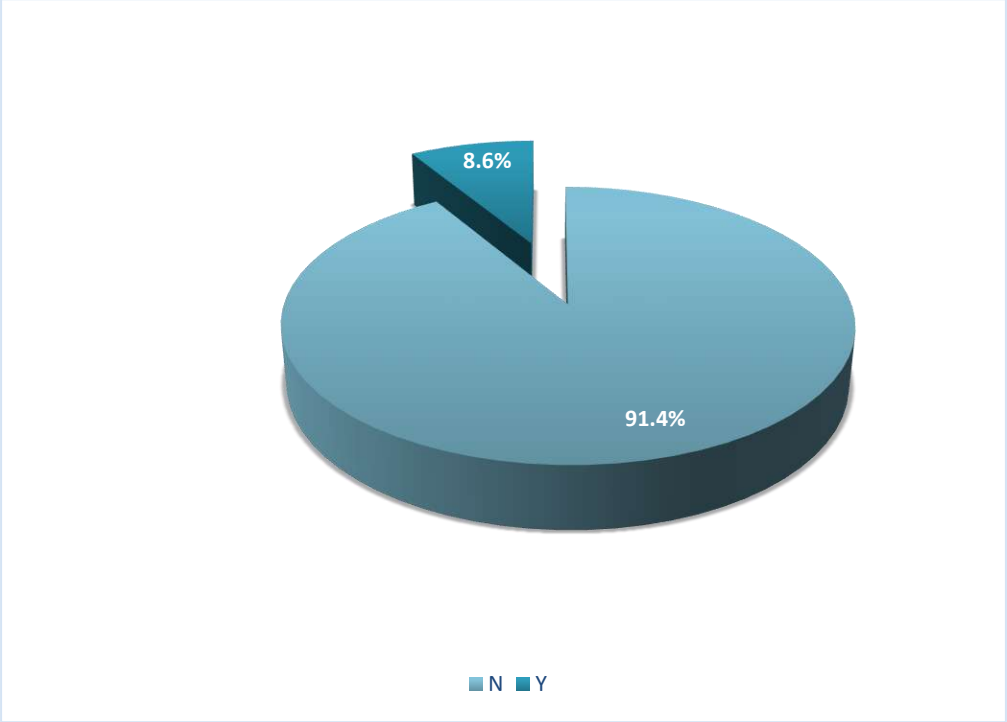

Figure 8: Pie chart depicting percentage of children with positive family history

PERINATAL INSULT: 46 children (79.3%) had normal birth history.

Seven children (12%) had perinatal asphyxia, and 2 children (3.4%) had neonatal hypoglycemia and two children were born premature (3.4%)

Table 12: Distribution of children based on effect of Perinatal insult leading to paroxysmal event

Birth history	No. of cases	Percentage
Normal	**46**	**79.3%**
Abnormal :	**12**	**20.7%**
Perinatal asphyxia	7	12 %
Hypoglycemia	2	3.4%
Prematurity	2	3.4%
Not known	1	1.7%
Total	58	100.0%

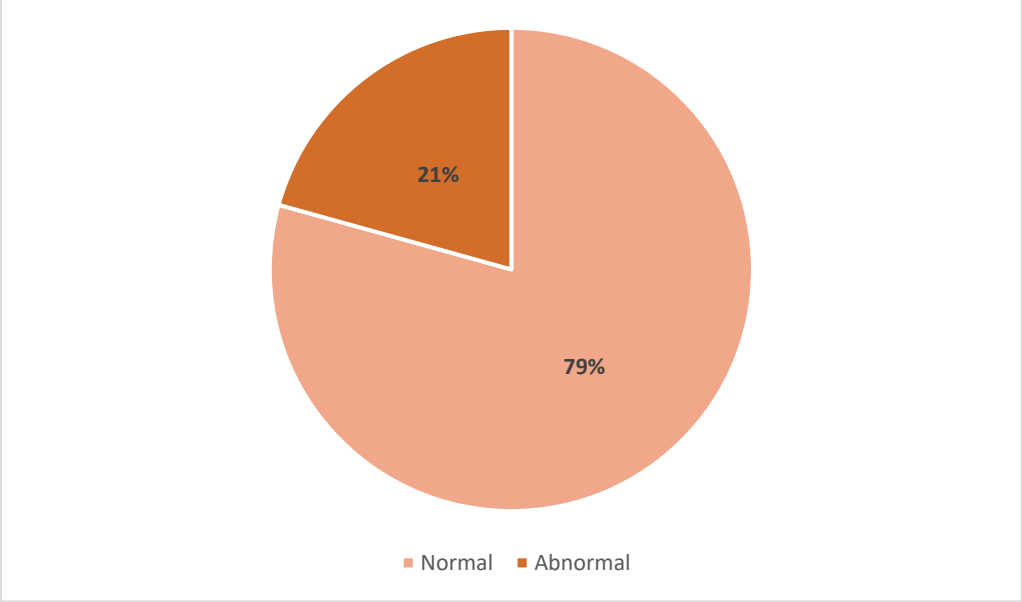

Figure 9: Pie chart depicting % of children with Abnormal birth history

DEVELOPMENTAL HISTORY Majority (67.2%) of the children were developmentally normal. Remaining 20 children were developmentally delayed including 1 with developmental regression.

Table 13: Distribution of children based on altered Developmental history

Development	No. of cases	Percentage
Delayed	19	32.8%
Normal	39	67.2%
Total	58	100.0%

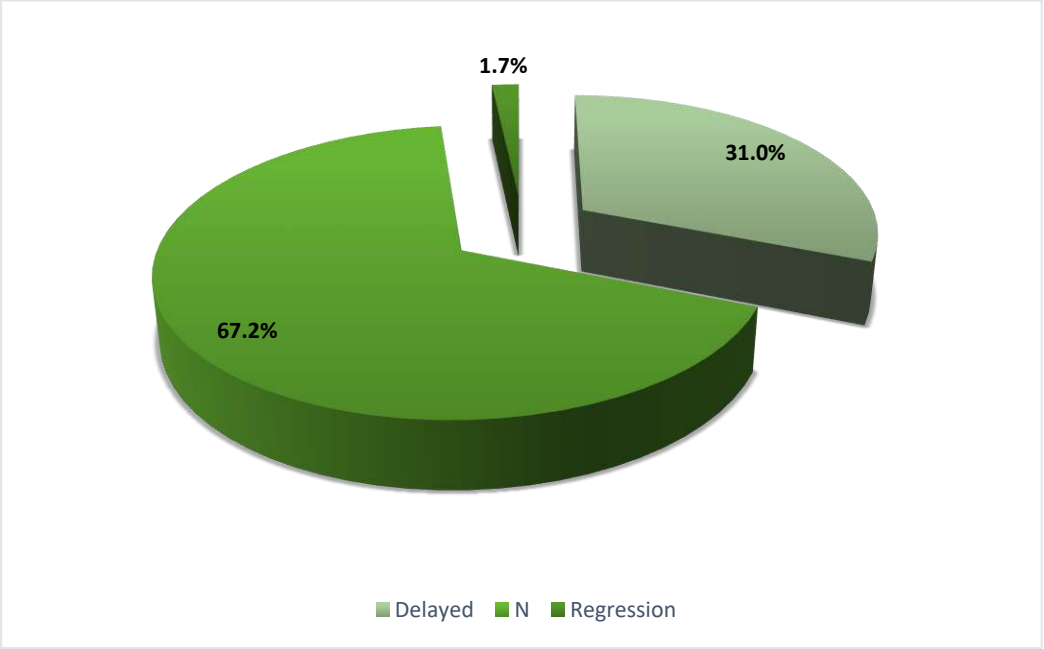

Figure 10: Pie chart representing % of children with Delayed Devlopment

PHYSICAL EXAMINATION

On physical examination, 10 children had abnormal signs including microcpehaly in 5 (8.6%), and ashleaf macules in 2. One child each had hyperpigmentation of skin and glossitis. One child was obese.

Table 14: Physical examination findings in children with paroxysmal events

Physical examination signs	No. of cases	Percentage
Microcephaly	5	8.6%
Ash leaf macules	2	3.4%
Hyperpigmentation of body	1	1.7%
Glossitis	1	1.7%
Obese	1	1.7%

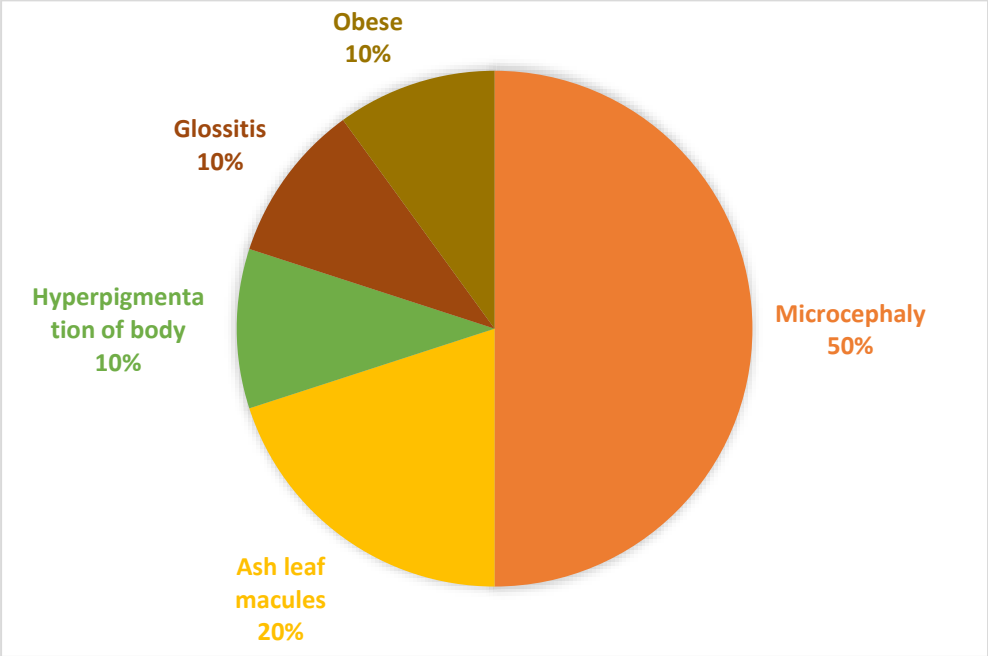

Fig 11: Pie chart depicting Abnormal physical examination findings in children

NEUROLOGICAL EXAMINATION

Neurological examination was abnormal in 13 (22.4%) (Cerebral palsy in 5, poor vision in 2, hypotonia in 3, opsoclonus myoclonus in 1, Meningeal signs in 1, and squint in 1) and normal neurolical examination in 45 children (77.6%).

Table 15: Case distribution based on Neurological examination in our study

Neurological examination	No. of cases	Percentage
Normal	45	77.6%
Abnormal	13	22.4%
Cerebral palsy	5	8.6%
poor vision	2	3.4%
Hypotonia	3	5.2%
OMAS	1	1.7%
Meningeal signs	1	1.7%
Squint	1	1.7%
Total	58	100.0%

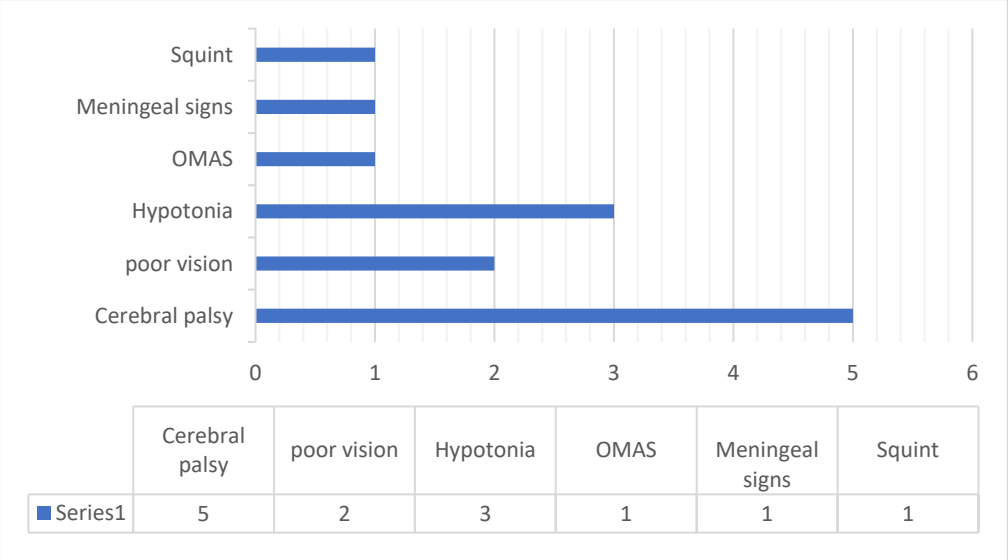

Fig 12: Clustered Bar depicting children with Abnormal neurological examination

EEG FINDINGS

53 children underwent EEG examination. EEG abnormalities were observed in 30 children (51.7%). Generalised EEG abnormalities were noted in 10, spike and wave discharges in 2, hypsarrhythmia in 10 and 7 children had focal epileptiform discharges. One child had generalised slowing of discharges suggestive of encephalopathy depicted.

Table 16: Case distribution of children based on EEG abnormalities

Normal	23
Abnormal	30
Generalised epileptic	10
Focal epileptic	7
Hypsarrythmia	10
Spike and wave	2
Generalised encephalopathy	1

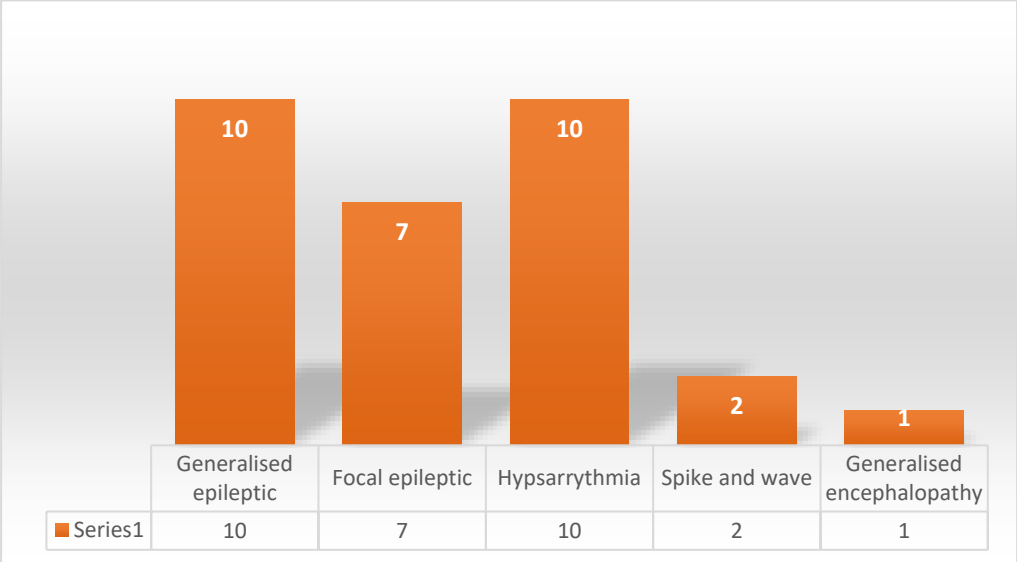

Fig 13: Clustered Column depicting EEG abnormalities found in children during our study

NEUROIMAGING FINDINGS:

49 children had an MRI, and it was abnormal in 14 children (24%). Abnormalities included PVL in 4 (6.9%), NHBI in 2 (3.4%), Hypoxic-ischemic in 2 (3.4%), tuberous sclerosis in 2 (3.4%) and miscellaneous in 4 (table 16 & fig. 15)

Table 17: Neuroimaging findings in children with paroxysmal events in our study

Neuroimaging	No. of cases	Percentage
Normal	35	60.3%
Abnormal	14	24.1%
PVL	4	6.9%
Neonatal Hypoglycemic brain injury	2	3.4%
Hypoxic ischemic	2	3.4%
Tuberous sclerosis	2	3.4%
Miscellaneous*	4	6.9%
Total	58	100.0%

*Meningoencephalitis, Microhaemorrhage, Internal capsule damage and Encephalomalacia

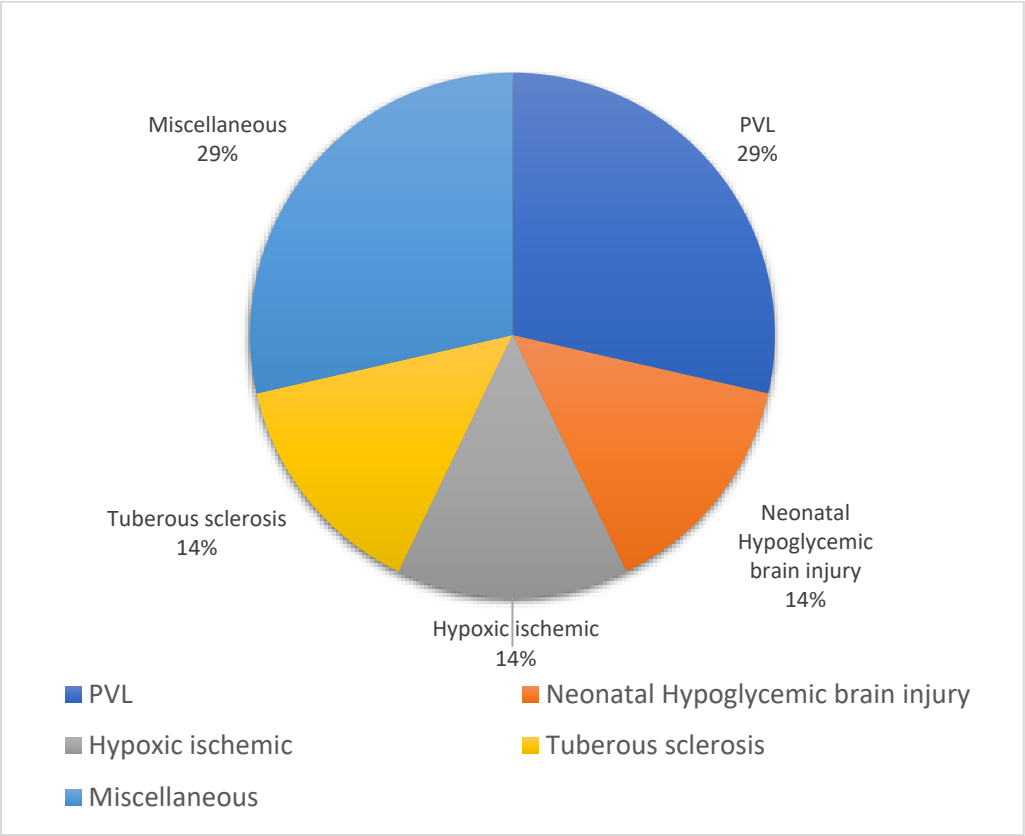

Fig 14: Pie chart depicting % distribution of children with Abnormal Neuroimaging

CLINICAL DIAGNOSIS (based on History and Physical Examination)

Table 18: Clinical diagnosis of paroxysmal events in children

Diagnosis	No. of cases	Percentage
Non-epileptic	10	17.2%
Epileptic	43	74%
Inconclusive	5	8.6%

Based on history and physical examination, out of 58 cases, 10 children (17%) were diagnosed as having non epileptic events, whereas 43 (74%) children were considered to have epileptic events and there were 5 children (8.6%) were said to be Inconclusive.

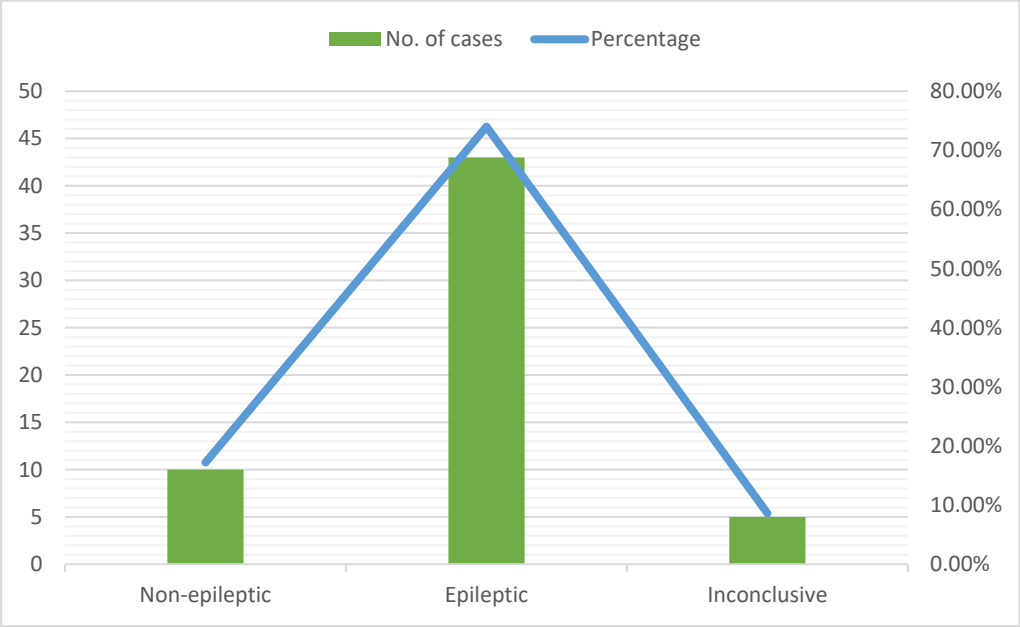

Fig. 15: Columns depicting differentiation of events based on clinical diagnosis

Table 19: FINAL DIAGNOSIS AFTER HISTORY+PHYSICAL EXAMINATION+VIDEO REVIEW

Final diagnosis	No. of cases	Percentage
Non-epileptic	18	31.0%
Epileptic	40	69.0%
Total	58	100.0%

After video-review was added to the history and physical examination, Non-epileptic events were diagnosed in 18 (31%) children compared with 10 (17%) a significant increase by 8 cases (13%).

Table 20: Distribution of paraoxysmal events into different categories based on History & Physical examination

Clinical Diagnosis -type	No. of cases
Non- epileptic	10
Benign Neonatal sleep myoclonus	1
Pseudoseizures	2
Myoclonus	5
Breath holding spell	1
Tremors	1
Epileptic	43
Focal	25
Focal tonic clonic seizures	11
Focal clonic seizures	14
Generalised	18
Generalised tonic clonic seizures	4
Generalised Tonic seizures	4
Absence seizure	1
Epileptic spasm	9
Inconclusive	5
Total	58

VIDEO DIAGNOSIS BY PEDIATRICIAN: Videos were reviewed by the pediatrician (SB) who was blind to the clinical history. 13 children (22.4%) were identified as having non-epileptic and 36 (62 %) as epileptic events and 9 events were labelled as Inconclusive (15.5%)

Table 21: Distribution of children based on Video diagnosis by a Pediatrician

DIAGNOSIS	No. of cases	Percentage
Non-epileptic	13	22.4%
Epileptic	36	62%
Inconclusive	9	15.5%
Total	58	100%

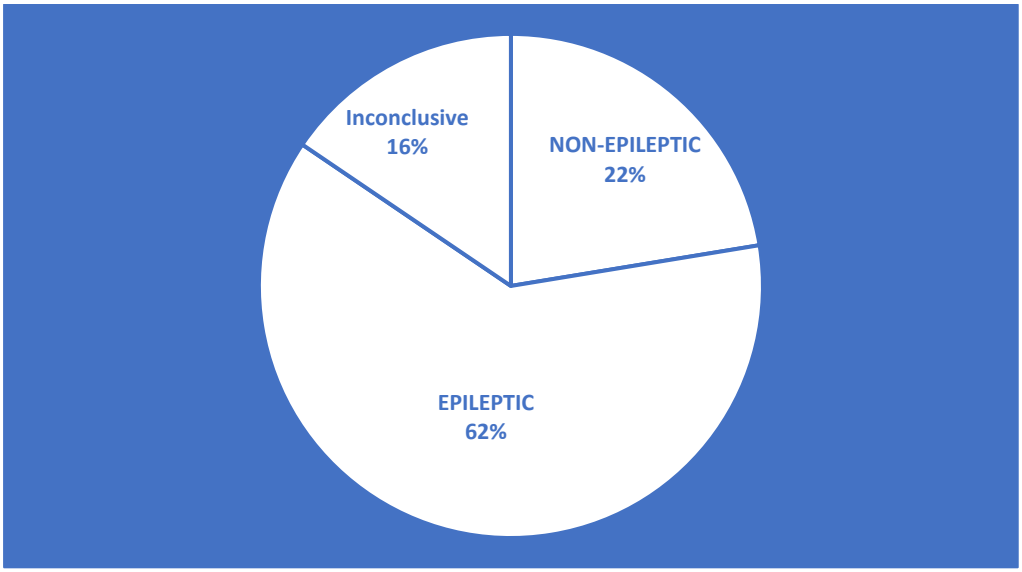

Fig. 16: Pie chart depicting % distribution of children based on video diagnosis by pediatrician

Table 22: Distribution of events based on Video Diagnosis by pediatrician

Video Diagnosis -type	No. of cases
Non- epileptic	13
Benign Neonatal sleep myoclonus	1
Pseudoseizures	7
Myoclonus	1
Blepharospasm	1
Dystonia	1
Gratification	1
Breath holding spell	1
Epileptic	36
Focal	14
Focal tonic clonic seizures	9
Subtle neonatal seizures	5
Generalised	22
Generalised tonic clonic seizures	10
Generalised Tonic seizures	2
Epileptic spasm	10
Inconclusive	9
Total	58

Video diagnosis by the Pediatrician concluded that there were 10 cases each of Generalised tonic clonic seizures and Epileptic spasms accounting upto 17.2% each respectively.

9 children were found to have Focal tonic clonic seizures accounting upto 15.5% of total cases followed by 7 videos reviewed as Functional seizures accounting upto 12.1% of total cases.

9 Videos were found to be Inconclusive as we could not specify the nature and type of the event accounting upto 15.5% of cases

6 videos concluded to be under category of Myoclonus, Blepharospasm, sleep myoclonus of infancy, Dystonia, Gratification disorder and Night terrors each contributing upto 1.7% of total videos

VIDEO DIAGNOSIS BY ADULT NEUROLOGIST: Out of 58 videos reviewed by Adult Neurologist, 31 were concluded to be Epileptic accounting upto 53.4% of cases whereas 10 videos were concluded to be Non- Epileptic accounting upto 17.2% of total cases, but there was 1 video in which the child was thought to have both epileptic and non-epileptic activities as well as 16 recordings were Inconclusive.

Table 23 : Video diagnosis by adult neurologist

DIAGNOSIS	No. of cases	Percentage
Non-epileptic	10	17.2%
Epileptic	31	53.4%
Binary (Epi + Non epi)	1	1.7%
Inconclusive	16	27.5%

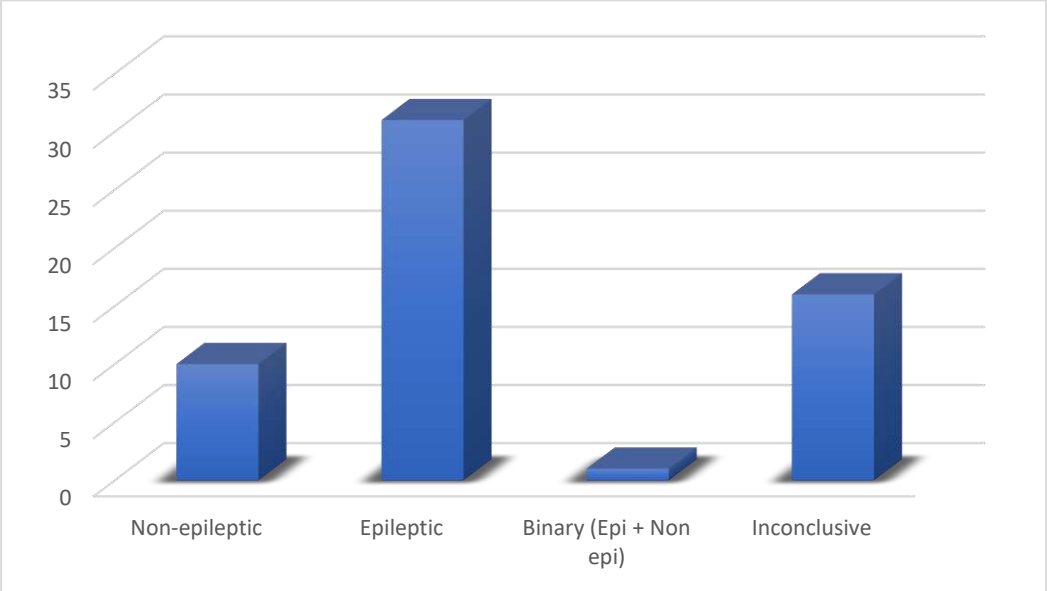

Fig. 17: 3D Columns depicting differentiation of events by adult neurologist

Table 24 : Distribution of events based on video diagnosis by adult neurologist

Video Diagnosis -type	No. of cases
Non-epileptic	10
Pseudoseizures	5
Benign neonatal sleep myoclonus	1
Blepharospasm	1
Myoclonus	3
Epileptic	20
Focal	10
Focal tonic clonic seizures	9
Subtle neonatal seizures	1
Generalised	21
Generalised tonic clonic seizures	10
Generalised Tonic seizures	4
Epileptic spasm	7
Inconclusive	17
Total	58

58 videos reviewed by Adult neurologist concluded 10 cases to be Generalised tonic clonic (17.2%) followed by 9 thought to be Focal tonic clonic seizures (15.5%) and 7 cases under category of epileptic spasms (12.1%)

3 videos were found to have Myoclonus accounting upto 5.2% of cases & 16 videos found to be Inconclusive accounting upto 27.6% of cases

4 children each put under the category of Blepharospasm, Sleep myoclonus of infancy, Subtle seizures.

VIDEO DIAGNOSIS BY PEDIATRIC NEUROLOGIST: 37 videos were concluded to be Epileptic (63.8%) of total cases whereas 21 cases concluded to be Non-epileptic (36.8%) of total videos.

Table 25: Distribution of children based on video interpretation by Pediatric neurologist into Epileptic and Non-epileptic events

Diagnosis	No. of cases	Percentage
Non-epileptic	18	31%
Epileptic	34	58.6%
Inconclusive	6	10.3%
Total	58	100%3

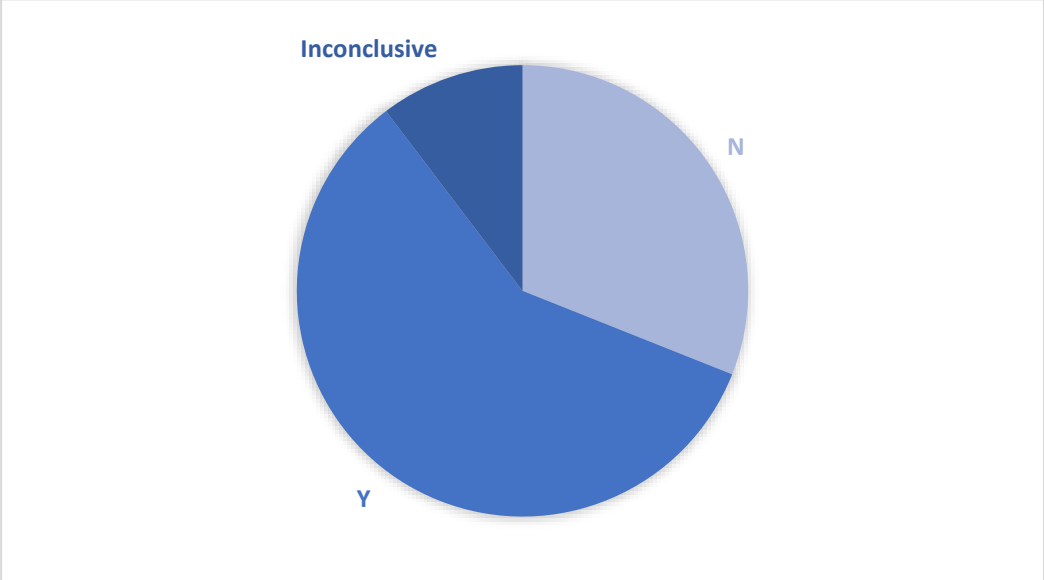

Figure 18: Pie chart depicting % distribution of children with paraoxysmal events based on Video diagnosis by Pediatric neurologist

Table 26: Distribution of events based on video diagnosis by pediatric neurologist

Video Diagnosis -type	No. of cases
Non-epileptic	18
Pseudoseizures	3
Benign neonatal sleep myoclonus	1
Blepharospasm	1
Myoclonus	5
Shuddering attack	1
Tremors	2
Gratification disorder	1
Breath holding spell	1
Hand flapping	1
Dystonia	2
Epileptic	34
Focal	20
Focal tonic clonic seizures	9
Focal clonic seizures	9
Multifocal clonic seizures	2
Generalised	14
Generalised tonic clonic seizures	5
Epileptic spasm	9
Inconclusive	6
Total	58

FINAL DIAGNOSIS OF PARAOXYSMAL EVENTS

Out of 58 children included in our study, 40 children were found to be having Epileptic activity accounting upto 69% of total whereas 18 children were found to have Non-Epileptic activity accounting upto 31% of total cases

Table 27: Case distribution based on final diagnosis of events

Final diagnosis	No. of cases	Percentage
Non-Epileptic	18	31.0%
Epileptic	40	69.0%
Total	58	100.0%

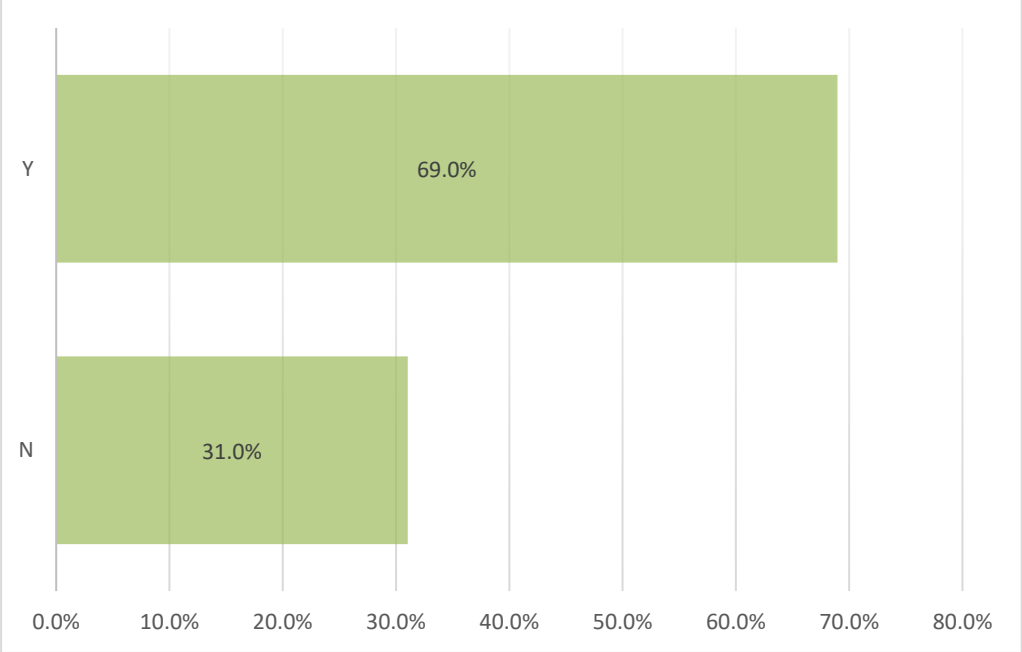

Figure 19: Bar graph showing % distribution of children into epileptic and non epileptic based on final diagnosis

Table 28: Distribution of events based on final diagnosis

Final Diagnosis -type	No. of cases
Non-epileptic	18
Pseudoseizures	3
Benign neonatal sleep myoclonus	1
Blepharospasm	1
Myoclonus	7
Dystonia	2
Shuddering attack	1
Tremors	1
Gratification disorder	1
Breath holding spell	1
Epileptic	40
Focal	23
Focal tonic clonic seizures	10
Focal clonic seizures	10
Multifocal clonic seizures	3
Generalised	17
Generalised tonic clonic seizures	5
Epileptic spasm	10
Absence seizure	2
Total	58

Table 29: Comparison between video-diagnosis by different experts with final diagnosis

Types of events	Video-SB	Video-GS	Video-JSG	Final diagnosis
Epileptic	36	31	34	40
Focal seizures	14	10	20	23
Generalized seizures	12	14	5	5
Epileptic spasms	10	7	9	10
Absence seizures	0	0	0	2
Non-epileptic	13	10	18	18
Shuddering attacks	0	0	1	1
BNSM	1	1	1	1
PNES	7	5	3	3
Dystonia	1	0	2	2
Blepharospasm	1	1	1	1
Myoclonus	1	3	5	2
Breath holding spell	1	0	1	1
Gratification disorder	1	0	1	1
Tremors	0	0	2	1
Inclonclusive	9	17	6	0

BIVARIATE ANALYSIS OF FINAL DIAGNOSIS WITH AGE AND GENDER

Bivariate analysis revealed lack of significance between epileptic and no-epileptic events for age and gender

Table 30: Comparsion data between final diagnosis, age and gender distribution

		Final diagnosis				**Total**	**Chi-square value**	**p-value**
		Non epileptic	**%**	**Epileptic**	**%**			
AGE	< 6 month	4	22.2%	15	37.5%	19	2.102	0.552
	< 1 yrs	7	38.9%	16	40.0%	23		
	1-2 yrs	4	22.2%	5	12.5%	9		
	> 2 yrs	3	16.7%	4	10.0%	7		
Total		18	100.0%	40	100.0%	58		
		Final diagnosis				**Total**	**Chi-square value**	**p-value**
		N	**N**	**Y**	**Y**			
Gender	Female	8	44.4%	12	30.0%	20	1.146	0.284
	Male	10	55.6%	28	70.0%	38		
Total		18	100.0%	40	100.0%	58		

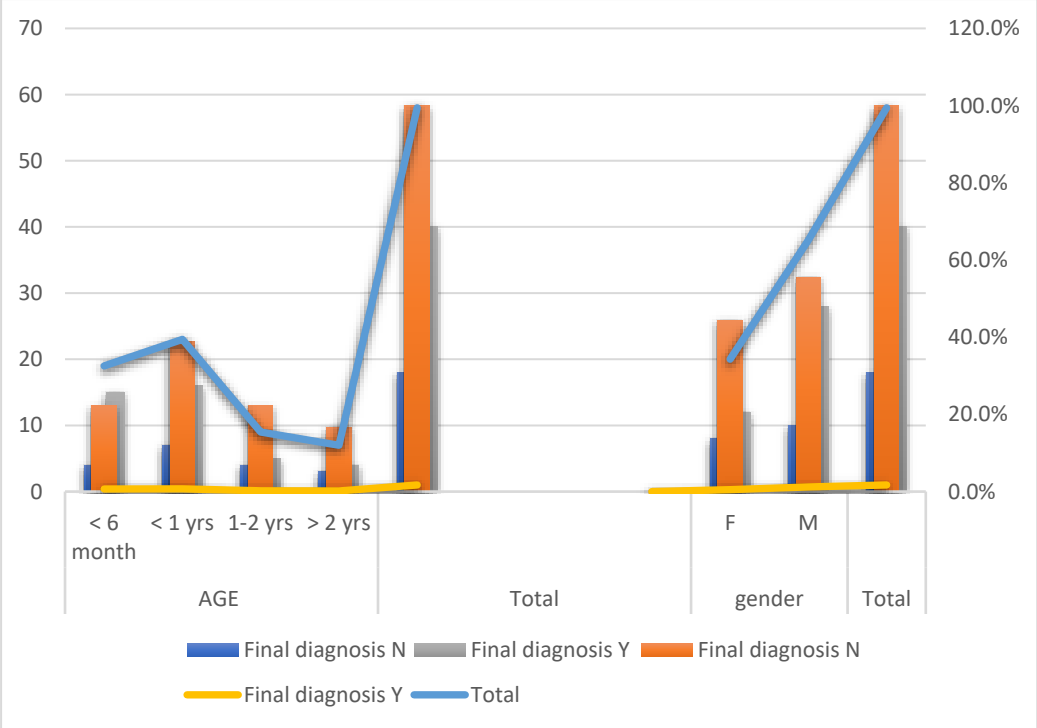

Figure 20: Clustered Columns and Lines depicting relationship between age, gender and final diagnosis

BIVARIATE ANALYSIS BETWEEN FINAL DIAGNOSIS AND TRIGGERING FACTORS FOR PARAOXYSMAL EVENTS

Table 31 A: Comparison data between possible triggers and final diagnosis of paroxysmal events

Trigger	Non epileptic	Epileptic	Total
yes	7	13	20
No	11	27	38
Total	18	40	58

Table 31 B: Distribution of children based on influence of triggering factors on final diagnosis

Triggers		Final diagnosis				Total	Chi-square value	p-value
		Non epileptic	%	Epileptic	%			
Triggers	After meals	1	5.6%	0	0.0%	1	16.811	**0.032**
	Crying	0	0.0%	1	2.5%	1		
	Emotions	2	11.1%	2	5.0%	4		
	Fever	0	0.0%	1	2.5%	1		
	Hyperventilation	1	5.6%	0	0.0%	1		
	less sleep	0	0.0%	9	22.5%	9		
	No trigger	11	61.1%	27	67.5%	38		
	stress	2	11.1%	0	0.0%	2		
	while playing	1	5.6%	0	0.0%	1		
Total		18	100.0%	40	100.0%	58		

7 children among non epileptic events and 13 children among epileptic events were found to have triggering factors associated with the event

COMPARISON DATA BETWEEN MOTOR SEMIOLOGY AND FINAL DIAGNOSIS

Individual semiological features were not significantly associated with epileptic or non-epileptic nature of the events

Table 32: Comparison data between nature of paraoxysmal events and final diagnosis

		Final diagnosis				Total	Chi-square value	p-value
		Non epileptic	%	Epileptic	%			
Uprolled eyes	No	13	72.2%	22	55.0%	35	1.539	0.215
	Yes	5	27.8%	18	45.0%	23		
Total		18	100.0%	40	100.0%	58		
Symmetry of movements	Bilaterally symm	15	83.3%	31	77.5%	46	0.576	0.750
	Both	0	0.0%	1	2.5%	1		
	Asymmetrical	3	16.7%	8	20.0%	11		
Total		18	100.0%	40	100.0%	58		
Stiffness	No	15	83.3%	24	60.0%	39	3.068	0.130
	Yes	3	16.7%	16	40.0%	19		
Total		18	100.0%	40	100.0%	58		
Clonic movements	Noe	11	61.1%	18	45.0%	29	1.289	0.395
	Yes	7	38.9%	22	55.0%	29		
Total		18	100.0%	40	100.0%	58		
Generalised/ Focal	Focal	3	16.7%	13	32.5%	16	1.558	0.342
	Gen.	15	83.3%	27	67.5%	42		
Total		18	100.0%	40	100.0%	58		

BIVARIATE ANALYSIS BETWEEN AWARENESS AND FINAL DIAGNOSIS: Loss of awareness was significantly (p=0.001) associated with differentiation between epileptic and no-epileptic spells (Table 33)

Table 33: Comparison between level of consciousness & final diagnosis of the event

		Final diagnosis				Total	Chi-square value	p-value
		Non epileptic	%	Epileptic	%			
Aware to environment	No	5	27.8%	32	80.0%	37	14.657	**0.001**
	Yes	13	72.2%	8	20.0%	21		
Total		18	100.0%	40	100.0%	58		

p-value was 0.001 (<0.05) significant indicating that the observed effect is unlikely to have occurred by chance alone.

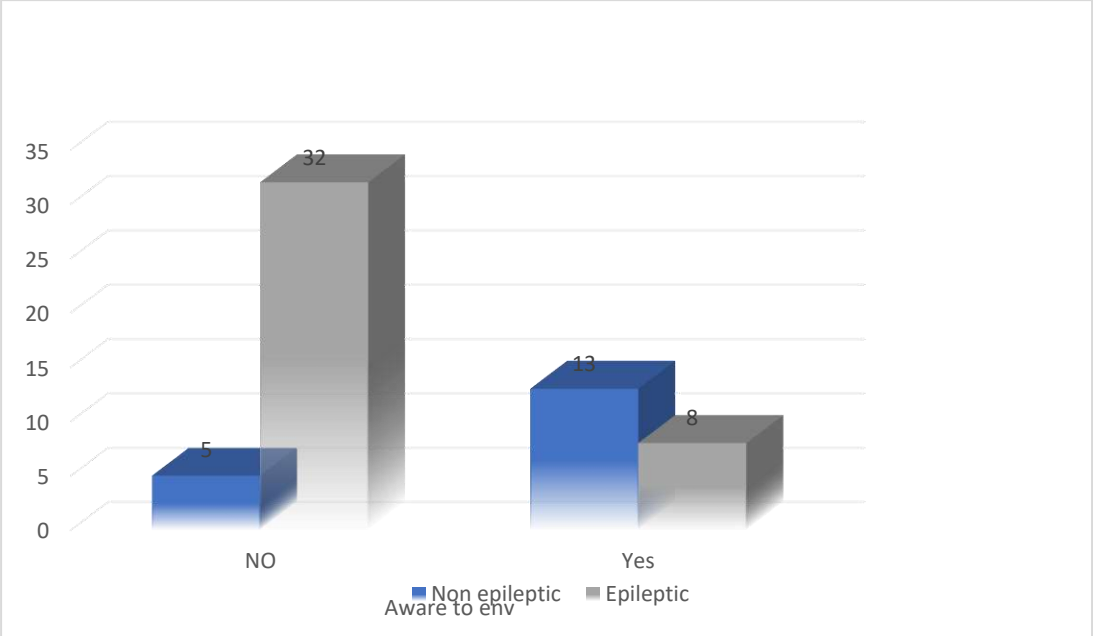

Figure 21: 3D Column graphics depicting effect of loss of awareness with final diagnosis

BIVARIATE ANALYSIS BETWEEN POST EVENT MENTAL AND PHYSICAL CHANGES WITH FINAL DIAGNOSIS : Children with epileptic events were found to have altered sensorium as compared to non epileptic events, hence, significant p-value (0.011)

Table 34 A: Comparison data depicting the observed relationship between post event status and final diagnosis

Post event sensorium	Non epileptic	Epileptic
Altered	5	33
Normal	13	7
Total	18	40

Table 34 B: Comparison data between altered mental status and outcome of event

		Final diagnosis				Total	Chi-square value	p-value
		Non epileptic	%	Epileptic	%			
post event	cant recall	0	0.0%	2	5.0%	2	19.933	**0.011**
	Cry	2	11.1%	9	22.5%	11		
	Cyanosed	1	5.6%	1	2.5%	2		
	Lethargy	2	11.1%	13	32.5%	15		
	limb weakness	0	0.0%	1	2.5%	1		
	Normal	11	61.1%	7	17.5%	18		
	recalls event	1	5.6%	0	0.0%	1		
	Sleeps	0	0.0%	7	17.5%	7		
	Watery eyes	1	5.6%	0	0.0%	1		
Total		18	100.0%	40	100.0%	58		

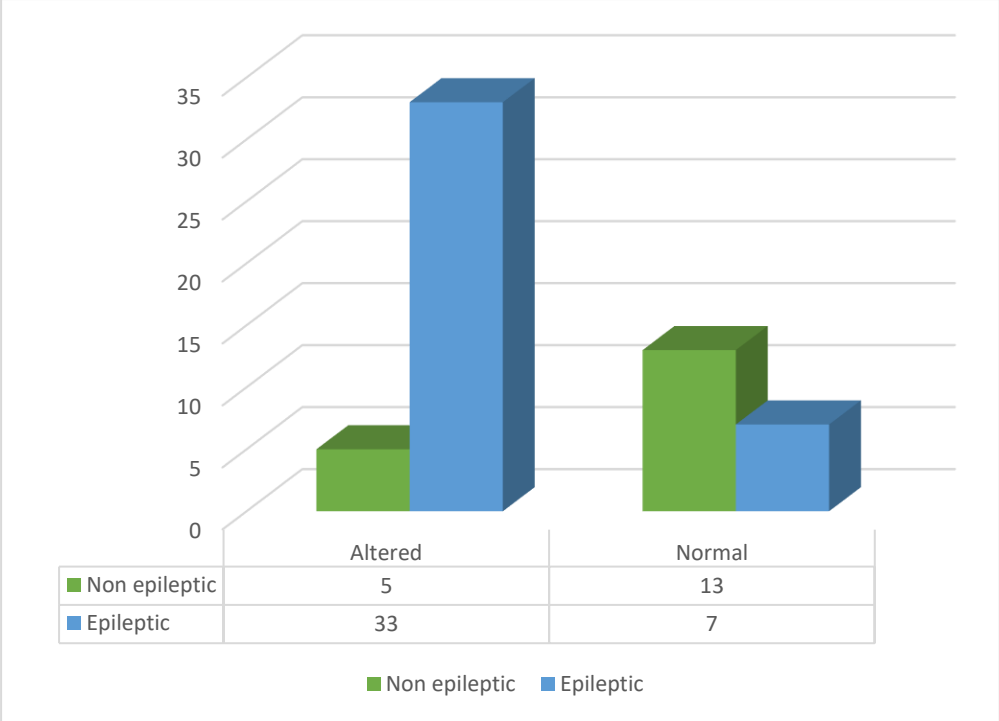

Figure 22: Comparison data between Post event status and final diagnosis of paroxysmal events

BIVARIATE ANALYSIS BETWEEN ABNORMAL NEUROLOGICAL EXAMINATION AND FINAL DIAGNOSIS

Abnromal Neurological examination found no significant relation with outcome of paroxysmal events

Table 35: Comparison data between abnormal neuro examination and outcome of events

	Final diagnosis		**Chi-square value**	**p-value**
Abnormal neurological examination	**Non epileptic**	**Epileptic**	8.163	0.613
Cerebral palsy	0	5		
Poor vision	0	2		
Hypotonia	0	3		
OMAS	1	0		
Meningeal signs	0	1		
Squint	1	0		

Out of 40 children diagnosed with Epileptic events in our study, 13 children were found to have abnormal neurological examination i.e. 5 had cerebral palsy, 3 were hypotonic, 1 each had OMAS, squint and meningeal signs.

BIVARIATE ANALYSIS BETWEEN EEG AND FINAL DIAGNOSIS OF PARAOXYSMAL EVENTS

Significance relation found between these 2 variables

Table 36: Comparison data between EEG findings and outcome of events

	Final diagnosis		**Chi-square value**	**p-value**
	Non epileptic	**Epileptic**	18.694	0.005
Abnormal EEG				
Focal epileptic	0	7		
Gen Epileptic	0	10		
Spike & wave	0	2		
Gen encephalopathy	0	1		
Hypsarrythmia	0	10		

Out of 40, 30 Children had abnormnal EEGs as 10 had Hypsarryhtmia, 7 had focal epileptic findings, 10 had generalised epileptic, 2 with spike & wave followed by 1 with encephalopathy.

Chi-square value was 18.6 and p-value was < 0.05 (significant) indicating that the observed effect did not occur by chance and has a positive relation between the 2 variables.

FINAL DIAGNOSIS VS VIDEO DIAGNOSIS BY PEDIATRICIAN

Table 37: Comparison between Final diagnosis vs Video diagnosis by Pediatrician

		Final diagnosis				Total	Kappa value	p-value
		Non epileptic	%	Epileptic	%			
Video diagnosis	Non epileptic	13	88.9%	4	10.0%	20	0.765	**0.001**
	Epileptic	5	11.1%	36	90.0%	38		
Total		18	100.0%	40	100.0%	58		

Video diagnosis by SB concluded that out of 18 non epileptic events (acc to final diagnosis), 13 were non epileptic and 5 were considered epileptic and out of 40 epileptic patients (acc to final diagnosis), 36 were considered epileptic and 4 as non epileptic.

p-value was 0.001 (<0.05) considered to be statistically significant thus, the observed effect has not occurred by chance.

Statistic	**Value**	95% CI
Sensitivity	**90.00%**	76.34% to 97.21%
Specificity	**88.89%**	65.29% to 98.62%
Positive Likelihood Ratio	**8.1**	2.18 to 30.04
Negative Likelihood Ratio	**0.11**	0.04 to 0.29
Disease prevalence (*)	**68.97%**	55.46% to 80.46%
Positive Predictive Value (*)	**94.74%**	82.92% to 98.52%
Negative Predictive Value (*)	**80.00%**	60.88% to 91.14%
Accuracy (*)	**89.66%**	78.83% to 96.11%

FINAL DIAGNOSIS VS VIDEO DIAGNOSIS BY ADULT NEUROLOGIST

Table 38: Bivariate analysis between video diagnosis by adult neurologist and final diagnosis

		Final diagnosis				Total	Kappa value	p-value
		Non epileptic	%	Epileptic	%			
Video diagnosis	Non epileptic	10	77.8%	9	15.0%	20	0.692	**0.001**
	Epileptic	6	16.7%	31	85.0%	37		
	Binary	1	5.6%	0	0.0%	1		
Total		18	100.0%	40	100.0%	58		

Video diagnosis by adult neurologist concluded that out of 18 non epileptic patients, 10 were considered non epileptic and 6 as epileptic with 1 child having both types of activities and out of 40 epileptic patients, 31 were considered epileptic and rest as non epileptic.

p-value was 0.001 (<0.05) considered significant that the chances of beta error/ false positives is <0.1%

16 video recordings were thought to be Inconclusive (type of activity couln't be specified)

Statistic	**Value**	95% CI
Sensitivity	**85.00%**	70.16% to 94.29%
Specificity	**82.35%**	56.57% to 96.20%
Positive Likelihood Ratio	**4.82**	1.71 to 13.56
Negative Likelihood Ratio	**0.18**	0.08 to 0.39
Disease prevalence (*)	**70.18%**	56.60% to 81.57%
Positive Predictive Value (*)	**91.89%**	80.10% to 96.96%
Negative Predictive Value (*)	**70.00%**	51.94% to 83.44%
Accuracy (*)	**84.21%**	72.13% to 92.52%

FINAL DIAGNOSIS VS VIDEO DIAGNOSIS BY PEDIATRIC NEUROLOGIST

Table 39 : Comparison data between Video diagnosis by pediatric neurologist and Final diagnosis

		Final diagnosis				Total	Kappa value	p-value
		Non epileptic	%	Epileptic	%			
Video diagnosis	Non epileptic	18	100.0%	6	15%	21	0.884	**0.001**
	Epileptic	0	0.0%	34	85%	37		
Total		18	100.0%	40	100.0%	58		

Data mentioned above depicts that out of 18 non epileptic recordings, 100% were correctly predicted by this physician as non epileptic and out of 40 epileptic video recordings, 34 were correctly predicted to be epileptic and 6 were misdiagnosed as non epileptic.

p-value was 0.001 (significant), thus the chances of false positives were <5%.

Statistic	**Value**	95% CI
Sensitivity	**92.50%**	79.61% to 98.43%
Specificity	**100.00%**	81.47% to 100.00%
Negative Likelihood Ratio	**0.07**	0.03 to 0.22
Disease prevalence (*)	**68.97%**	55.46% to 80.46%
Positive Predictive Value (*)	**100.00%**	90.51% to 100.00%
Negative Predictive Value (*)	**85.71%**	66.89% to 94.69%
Accuracy (*)	**94.83%**	85.62% to 98.92%

FINAL DIAGNOSIS VS CLINICAL DIAGNOSIS

TABLE 40: Bivariate analysis between clinical diagnosis and final diagnosis

		Final diagnosis				**Total**	**Kappa value**	**p-value**
		Non epileptic	**%**	**Epileptic**	**%**			
Clinical diagnosis	Non epileptic	10	38.9%	-	-	10	0.358	**0.003**
	Epileptic	8	61.1%	43	92.5%	48		
Total		18	100.0%	40	100.0%	58		

Out of 18 non epileptic patients, clinical diagnosis (based on history and examination) concluded that 8 were misdiagnosed as epileptic and rest were correctly classified as non epileptic and among 40 epileptic patients, 43 classified as epileptic so,3 children were misdiagnosed as epileptic.

p-value was 0.003 (<0.05) considered significant

Statistic	**Value**	95% CI
Sensitivity	**92.50%**	79.61% to 98.43%
Specificity	**38.89%**	17.30% to 64.25%
Positive Likelihood Ratio	**1.51**	1.04 to 2.21
Negative Likelihood Ratio	**0.19**	0.06 to 0.66
Disease prevalence (*)	**68.97%**	55.46% to 80.46%
Positive Predictive Value (*)	**77.08%**	69.72% to 83.09%
Negative Predictive Value (*)	**70.00%**	40.48% to 88.90%
Accuracy (*)	**75.86%**	62.83% to 86.13%

COMPARISON OF VIDEO DIAGNOSIS BETWEEN 2 PHYSICIANS

TABLE 41: Bivariate analysis between 2 physicians based on video diagnosis

		VD-JSG				Total	Kappa value	p-value
		Non epileptic	%	Epileptic	%			
VD-SB	Non epileptic	13	85.7%	-	-	20	0.811	**0.001**
	Epileptic	5	14.3%	36	94.6%	38		
Total		18	100.0%	34	100.0%	58		

Out of 37 patients diagnosed as epileptic by pediatric neurologist, 36 were diagnosed as epileptic by pediatrician whereas out of 18 non epileptic children (based on VD by pediatric neurologist) 13 were correctly diagnosed (85.7%) as non epileptic

Statistic	**Value**	95% CI
Sensitivity	**94.59%**	81.81% to 99.34%
Specificity	**85.71%**	63.66% to 96.95%
Positive Likelihood Ratio	**6.62**	2.32 to 18.93
Negative Likelihood Ratio	**0.06**	0.02 to 0.25
Disease prevalence (*)	**63.79%**	50.12% to 76.01%
Positive Predictive Value (*)	**92.11%**	80.32% to 97.09%
Negative Predictive Value (*)	**90.00%**	69.80% to 97.23%
Accuracy (*)	**91.38%**	81.02% to 97.14%

COMPARISON OF VIDEO DIAGNOSIS between ADULT NEUROLOGIST & CHILD NEUROLOGIST

Table 42: Bivariate analysis between video diagnosis of 2 physicians

		VD-JSG				Total	Kappa value	p-value
		Non epileptic	%	Epileptic	%			
VD-GS	Non epileptic	16	76.2%	4	10.8%	20	0.641	**0.001**
	Epileptic	4	19.0%	33	89.2%	37		
	Y + N (excluded)	1	4.8%	0	0.0%	1		
Total		21	100.0%	37	100.0%	58		

Statistic	Value	95% CI
Sensitivity	89.19%	74.58% to 96.97%
Specificity	80.00%	56.34% to 94.27%
Positive Likelihood Ratio	4.46	1.84 to 10.79
Negative Likelihood Ratio	0.14	0.05 to 0.35
Disease prevalence (*)	64.91%	51.13% to 77.09%
Positive Predictive Value (*)	89.19%	77.32% to 95.23%
Negative Predictive Value (*)	80.00%	60.71% to 91.19%
Accuracy (*)	85.96%	74.21% to 93.74%

Table 43: Analysis between age and final diagnosis

	Final diagnosis	Total cases	Mean	Std. Deviation	Std. Error Mean	Z	p-value
Age	Non epileptic	18	18.9	24.8	6.0	-1.425	0.154
	Epileptic	40	11.8	11.0	1.7		

DISCUSSION

Our study provides evidence for the diagnostic value of smartphone videos in children outpatients with paroxysmal events, enabling physicians to distinguish between epileptic and non-epileptic disorders, classify seizures into generalized or focal onset, subtype each seizure type into further categories such as tonic-clonic, tonic, clonic, myoclonic, epileptic spasms and others to some extent. In case of non-epileptic disorders, home videos allowed categorization into specific diagnoses such as benign neonatal sleep myoclonus, breath-holding spells, gratification phenomenon, or a movement disorder. Most importantly, we found that home-videos were confirmatory of the clinical diagnosis made on the basis of clinical history and physical examination. If seen in the context of the fact that paroxysmal events (both seizures and non-seizures) rarely occur in front of the physician but are diagnosed on the basis of historical information provided by the family members who may not have witnessed the event. Therefore, there is always a possibility of mis- or missed-diagnosis even in the expert hands if the information asked or received from the witness is incomplete. It can happen because of time constraints or lack of knowledge about specific events. It is not uncommon to see non-epileptic spells being misdiagnosed and treated as epilepsy. Home videos provide “live replay” of the event, thus either re-affirming or refuting the clinical suspicion, and guiding further investigations and treatment. Although video-EEG is the gold standard for diagnosis of epilepsy and its differentiation from non-epileptic spells, facilities are not easily available or accessible on demand. Home videos thus provide a viable alternative to video-EEG in aiding the clinical diagnosis.[12]

Smart phones are ubiquitous and easily available in most situations. Its operation, including video-recording requires little if any training. Videos provide permanent record of the event, can be reviewed multiple times, shared across multiple platforms and with multiple experts for opinion. It is not surprising that several studies from

different geographical regions have attested to its utility in the diagnosis of epileptic as well as non-epileptic disorders in children as well as adults. It however, requires that paroxysmal events are frequent enough and of sufficient duration to allow parents or other family members to record it.

We restricted our study exclusively to children (up to 18 years of age) only because the spectrum of both epileptic and non-epileptic paroxysmal disorders in children is quite different from that in adults. In particular, certain epileptic disorders such as epileptic spasms and non-epileptic disorders such as benign neonatal sleep myoclonus, benign paroxysmal vertigo /torticollis, shuddering episodes, breath-holding spells, and gratification phenomenon etc. are seen only in young children and not in adults. Previously, very few studies have been done only on children alone (Huang [25], Gowda[24,] Johanson[40]). Majority of the studies have included adult patients (Samuel[31], Dash [20], Tatum[26], Ojeda [29], Samuel[31], Chenn[37], Erba [38], Yeh[39]) or mixed cohort of children and adults (Benniczky[21], Ramanujann [27,] Goodwin [30]). Also, 3/4th of the children with paroxysmal events in our study were younger than 5 years, as the paroxysmal events especially non-epileptic, are more common at this age than during later years (Gowda [24)].

In our study, boys outnumbered girls by 1.9:1. Male preponderance was also reported by Gowda et al [24], and could reflect gender based bias which is common to our country. Behavioural stereotypes as boys are perceived to be more active or having risk taking behaviour, which can lead to more attention, differences in symptom presentation, parental perceptions, access to health care and educational and societal factors. Many other studies have not commented on gender ratio, as they largely involved video-interpretation by experts, rather than demographic characteristics of the patients whose videos were being reviewed.

In Majority (56.9%) of the children, the event lasted <1 minute, followed by 1-5 minutes in 18 children (31%) and 5-10 minutes in 5 children (8.6%). Only 2 children had events lasting > 10 minutes. Duration of events was not found to be differentiating between epileptic or non-epileptic events. Majority of the children had daily spells which allowed easy video-recording.

Recorded events were classified into epileptic and non-epileptic. In some cases, the diagnosis remained inconclusive even after the videos were added to the clinical history. We found epileptic events to be more as compared to non-epileptic. Many of the non-epileptic disorders such as breath-holding spells, gratification and shuddering are a very frequent occurrence, particularly in infants and young children but are not video-recorded and hence not brought to medical attention because parents and grandparents are generally aware of their occurrence and self-limited nature as well as their eventual recovery with time. Also these disorders are considered by the family as aberrant behavior and not a medical disorder requiring intervention. In older children, syncope and psychogenic non-epileptic seizures are common. Syncope, induced by pain or fear, prolonged standing and unpleasant stimuli such as sight of blood is particularly common but very brief in nature with child waking up soon after falling to ground, precluding video-recording.

Among epileptic events, most commonly recorded events were epileptic spasms in 10, focal tonic clonic or focal clonic seizures in 10 children each. Generalized tonic clonic seizures occurred in 5, multifocal clonic seizures in 3 and absence seizures in 2 children. Epileptic spasms are generally easy to record because of the high frequency and predictability of occurrence. They occur daily, often after awakening from sleep and in clusters allowing video-recording. Other seizures were again recorded because of high frequency of occurrence. Among non-epileptic events, most common was myoclonus in 7 followed by pseudoseizures in 3 and dystonias in 2. One child each was diagnosed with blepharospasm, benign neonatal

sleep myoclonus, gratification disorder, tremors, breath holding spell and shuddering attack. Most of these non-epileptic events are common in clinical practice, are of high frequency, with some occurring several times a day (pseudoseizures, benign neonatal sleep myoclonus, gratification), or tend to last several minutes allowing video-recording by caregiver. It is important to note that these disorders are frequently mis-diagnosed as epileptic spells. Home video provide an important adjunctive tool to reach an accurate diagnosis and prevent over-diagnosis of epilepsy. A trigger for the paroxysmal event was identified by parents in 20 (34.5%) cases whereas No trigger was identified in 38 (65.5%) children. Possible triggers were sleep deprivation, emotional upset, fever, crying, meals, and hyperventilation. Triggers are more often and more clearly identified with non-epileptic events than with epileptic events.

We analysed motor semiology including uprolling of eyes, symmetry of movements, clonic or tonic nature of event, generalised or focal involvement. Uprolling of eyes was observed in 23 cases. Motor semiology had no significant effect on the outcome of event. On the other hand, there was a significant effect of impaired awareness with the type of paroxysmal events. Thirty-seven (63.8%) children who had impaired awareness, all of them were categorised to have epileptic events. Impaired awareness is a characteristic feature of most of epileptic spells. Only rarely, patients have preserved awareness during the epileptic events, and many cases, events evolves into impaired consciousness later during the course of event. On the other hand, loss of awareness is infrequent in non-epileptic spells other than syncope, breath-holding spells and psychogenic nonepileptic events (pseudoseizures). Syncope and breath-holding spells are rarely captured on home videos. Syncope most often occur outside home settings such as school, and are therefore rarely recorded on smart phone. Breath-holding spells are also generally non-captured on smart phone because of the panic they cause to the parents.

Twelve children were found to have a perinatal insult in the form of asphyxia in 7, prematurity in 2 and neonatal hypoglycemia in 2. All these children were diagnosed with epileptic nature of the event. Nineteen children had developmental delay and most of them presented with epileptic event. Signs on physical examination were microcephaly, ash leaf macules, hypertonia (spasticity), hyperreflexia etc. (Table 14) were associated with epileptic events in our study. These physical signs indicate underlying brain injury (genetic or acquired), and are often seen in children with epilepsy, though the presence of these signs does not exclude the diagnosis of non-epileptic spells. While epilepsy can occur in children without abnormal signs on physical examination, epileptic spasms (one of the most common type of epileptic events in our study) are mostly symptomatic of underlying brain pathology with only about 20% being “idiopathic” in nature [42]. These findings are important because it is well known that in children majority of the non-epileptic events such as benign neonatal sleep myoclonus, shuddering episodes, breath-holding spells, gratification phenomenon, opsoclonus myoclonus ataxia syndrome, syncope etc., occur in previously normal children with normal development and neurological examination.

Thirty children had EEG abnormalities including generalised spike and wave discharges in 10, hypsarrhythmia in 10 and 7 children had focal epileptiform discharges. This is not surprising since children with epilepsy are more likely to exhibit EEG abnormalities compared with children with non-epileptic events (though epileptiform discharges are not necessary for the diagnosis of epilepsy, which is largely a clinical diagnosis). Conversely, a diagnosis of non-epileptic event is unlikely to be associated with epileptiform discharges (though the presence of epileptiform abnormalities does not exclude the diagnosis of non-epileptic), and a neurologist is less likely to order EEG if the diagnosis of non- epileptic event is clinically very certain, more so when home-video is available to confirm it.

Similarly, neuroimaging abnormalities which suggest underlying brain pathology such as periventricular leukomalacia, hypoxic ischemic injury, neonatal hypoglycemic brain injury, tuberous sclerosis are more likely to encountered in children with epileptic spells than those with non-epileptic events. Like abnormal findings on physical examination and EEG, neuroimaging abnormalities per se do not distinguish between epileptic and non-epileptic nature of spells.

The present study was done in out-patient setting where majority of the children with paroxysmal events present, and mimicked real-life experience. Patients came to the pediatric neurology out-patient and brought home videos of the recorded events, a common clinical scenario which we have noticed in the current times of high penetration of smart phone technology. It allowed us to view the recorded videos in the clinic itself to determine the accuracy of our clinical diagnosis and guide further intervention. On initial clinical evaluation by history and physical examination, 43 children were suspected to have epileptic events, and 10 with non-epileptic spells. In 5 children, the diagnosis remained inconclusive. With the addition of video, the 3 epileptic events and 5 inconclusive events were classified as non-epileptic resulting in 8 additional children being diagnosed with non-epileptic spells. Statistical analysis comparing video diagnosis with final diagnosis revealed 92% sensitivity with 95% CI (79.6% to 98.3%) and 100% specificity with 95% CI (81% to 100%) with diagnostic accuracy of 94.8%. Since access to video-EEG was not possible, we used clinical history, physical examination, laboratory investigations such as EEG and brain MRI as a gold standard for final diagnosis for comparison purposes.

Many other studies done under different settings such as outpatient, epilepsy monitoring units, ambulatory EEG etc. have corroborated the role of home videos in the assessment of patients presenting with paroxysmal epileptic and non-epileptic events.

Dash et al (2016)[20] studied the feasibility and yield of semiological features from home videos and compared them with those deduced from clinical history in epileptic patients in the setting of a developing country (India). Mean age of the patients was 26.76 ± 7.5 years. Home videos were available for 312 patients. Home videos detected significantly more semiological signs than the history alone. A larger number of patients could be correctly categorized into the focal epilepsy group from home videos compared to when medical history was used. Videos which included bilateral generalized clonic movements of limbs, motor movement around mouth, fear, visual phenomena, hemisensory phenomena, and post-ictal unilateral weakness had the highest accuracy. The authors concluded that in persons with epilepsy, home videos were more reliable in detecting semiological signs and classifying epilepsy type than the history alone provided by caregivers. In a developing country like India, home videos could be an important complementary tool for accurate semiological classification of epileptic seizures.

In another study, Beniczky et al. [21], assessed the accuracy of the interpretation of seizure semiology inferred from witnessed seizure descriptions and from video recordings. Five epileptologists evaluated 41 seizures from 30 consecutive patients who had clinical episodes in the epilepsy monitoring unit. For each clinical episode, the consensus conclusions (at least 3 identical choices) was reached in significantly more cases on the basis of interpretation of video recordings (88%) than on the descriptions (66%), and the overall accuracy was higher for the video recordings (85%) than for the descriptions (54%). Video recordings significantly increase the accuracy of seizure interpretation.

Amin et al. [22] prospectively compared the diagnosis based on smartphone videos to the final diagnosis based on standard video-EEG monitoring. Of the 54 adult patients (mean age 34.7 years and 59% female) included in the study, 36 had conclusive data (both on smart phone videos and video-EEG monitoring), and 18 nonconclusive. Mobile phone video and video-EEG were in agreement in 34 (94%). Of

these, 13 had epileptic and 23 non-epileptic spells. Authors concluded that interpretable home-recorded smartphone videos were helpful adjunctive tool in the diagnosis of seizure-like events.

In a recent systemic review, Ricci and colleagues[23] analyzed published reports about the use of home videos in the differential diagnosis of paroxysmal seizure like episodes. Seventeen studies were included in the review.

Gowda et al [24], found home-video to be useful in 35% cases with Gowda and colleagues from South India prospectively studied nonepileptic events in children up to 18 years of age. A total of 3660 children presented with paroxysmal events, out of which 285 (8%) had non-epileptic events. Home videos were found to be useful in the diagnosis of specific non-epileptic events in 35% children. [19] Usefulness of a confirmed diagnosis by the home video cannot be over emphasized here. Where the video diagnosis was not consistent with clinical diagnosis, we reviewed the history with the family again. In other instances, video provided a clear alternative diagnosis. Thus we were able to avoid un-necessary diagnostic and therapeutic interventions in such cases.

Huang et al. (2019), [25] from China investigated the role of smart phone videos in enhancing the diagnostic accuracy and as a result cost savings of paroxysmal events in infants. They asked 452 practitioners to diagnose paroxysmal events from the clinical descriptions and home video in 12 infants. The mean correct diagnoses with videos were 8.4 (SD 1.7) of 12 and without videos 7.5 (SD 1.7) of 12. For seizures, mobile phone videos increased the mean accurate diagnoses by 3.9% and 11.5% for nonepileptic events. The results were statistically significant. Pediatric neurologists with longer experience had higher diagnostic accuracy. There was significant cost saving. The authors concluded that home videos made on mobile phones were a cost-effective tool for the diagnosis of paroxysmal events in infants.

In another prospective and masked study, Tatum et al [26] collected a convenience sample of 44 smartphone videos from outpatient patients. These patients were formally investigated with video EEG telemetry to definitively confirm whether the events were epileptic or non-epileptic seizures. A study group of 530 epileptologists and trainees blinded to the diagnosis were shown the videos. About 80% of recorded videos were ranked by reviewers as having adequately good quality. Smartphone video was accurate in predicting diagnosis of epileptic seizures by experts 89.1% (95% CI, 84.2%-92.9%) of the time, with a specificity of 93.3% (95% CI, 88.3%-96.6%). Resident responses less accurate, despite greater confidence. Motor signs during events increased accuracy. Addition of history and examination to video, diagnoses rose from 78.6% to 95.2%. A correct diagnosis was 5.45 times greater when smartphone video accompanied history and examination (95% CI, 1.01- 54.3; P = 0.02). The authors concluded that outpatient smartphone video review by experts had predictive and additive value for diagnosing epileptic seizures.

Ramanujam et al. [27] assessed the contribution of home-videos to diagnosing psychogenic nonepileptic seizures (PNES). Caregivers of consecutive patients (N=783) attending a neurology service between 10 and 50 years of age were invited to make home recordings of their events. Of this group 269 videos were considered of fair or good quality and included. Videos of all recruited subjects were reviewed by the epilepsy fellow blinded to clinical history (step 1). All patients subsequently underwent vEEG which were reviewed by an epileptologist blinded to the diagnosis formulated by the epilepsy fellow (step 2). The diagnosis at step 1 was epileptic seizures in 71.4% and PNES in 27.1%. Diagnosis at step 2 was epileptic seizures in 73.6% and PNES in 25.3%, other physiologic events in less than 1% and There was a concordance between the diagnoses in steps 1 and 2 of 97.2% of subjects with no statistically significant difference between the diagnoses of steps 1 and 2. The most commonly noted semiological features on home videos pointing to diagnosis of PNES were, eye

closure; accuracy of 96.2% (95% CI: 92.3%-98.45%) Crying or shouting; accuracy of 89.6% (95% CI: 83.1%- 93.2%) Hyperventilating; accuracy 89.1% (95% CI: 83.7%- 93.2%) wild, uncoordinated movements; accuracy 71.74% (95% CI: 64.6%-75.7%) Lying still/no movements; accuracy 81.6% (95% CI: 75.3%-86.8%). The study authors concluded that good quality home-videos were likely useful to differentiate PNES from epileptic seizures and can complement vEEG in diagnosing PNES in a cost effective way.

Wasserman et al (2017)[28] recruited 46 clinicians consisting of 20 neurologists and 26 non-neurologists, and showed them 10 videos (5 psychogenic non-epileptic seizures and 5 epileptic seizures). Epileptologists diagnosed correctly 87.5% of cases, General neurologists 72.8%. Neurology nurses 69.8%, ER nurses 58%, Internal Medicine physicians 54.1% and ER physicians 44.4%. Statistical significant difference between the general physicians to all neurology group professions was >0.05. Clinicians with neurology training were statistically more likely to recognise seizures through the semiology viewed on the videos than the general physicians.

Ojeda et al (2016)[29] consecutively invited caregivers of adult patients attending an epilepsy clinic to record home videos of events. These were assessed by three neurologists and epileptologists who attempted to differentiate if events were epileptic or not. They then reviewed the patients at a later point with the addition of other information including history and investigations, to assess if the original diagnosis changed. Fifty percent of the patient's caregivers elected not to be part of the study citing that it would be too challenging to capture an event. From the original 317 patients, after recruitment completed and only viable videos were included, the group had 50 videos from 22 patients to analyse. The study found homemade videos to be of diagnostic value in epilepsy management.

Goodwin[30] and colleagues studied the role of addition of home videos to outpatient ambulatory EEG. All ambulatory EEG patients, 93 adults

and 37 children, were offered a camcorder to take home during a 17-month study period. Of the 45 patients (35%) who accepted, an ictal event occurred in 34 patients (76%), and in 17 (50%) of these an attack was captured successfully on video. Attacks were captured with greater success in children (14/23, 61%) than adults (3/11, 27%). Of the 17 video recordings, 14 (82%) were helpful in aiding interpretation of the ambulatory EEG. Authors concluded that home video facilities aided interpretation of ambulatory EEG recordings in approximately one third of patients.

Samuel and Duncan[31] used a portable video camcorder to record events from 22 adult patients aged 15-55 years with undiagnosed seizures. The videotapes assisted the diagnosis of non-epileptic attacks in nine of 22 patients (41%), and of epileptic attacks in eight of 22 patients (36%). Five patients (23%) could not be filmed, three of whom had seizures that were too short lived to be recorded. In two patients (9%) a confident diagnosis of non-epileptic seizures could be made from the videotapes alone. Seven patients subsequently required video-EEG telemetry. It was concluded that the handheld video camera was a useful and inexpensive tool to provide accurate seizure descriptions but should be used in conjunction with other evidence to classify seizures. Interactions with patients during filming were also observed to be particularly helpful. Installation of a video-TV observation system in a bedroom at home was found to decrease the stress level improved the quality of life in many families (Johanson 37) who were worried about their child having seizures while sleeping in another room.

Kadiwal et al[32] conducted a survey among healthcare workers on use of home video recordings aiding in diagnosis of neurological disorders in children. Most experts agreed that use of home videos improves patient care by 93%, reduced the need for further investigations and hospital admissions by 67% and 68.5% respectively.

A study by Seon jeon jung [33]on challenges of paroxysmal non epileptic events in infants did evaluation based on clinical and video diagnosis of paroxysmal events found jitteriness in newborns, shivering in early infancy & breath holding spell in late infancy are common PNEs. The best choice for infants with paroxysmal events on their initial visit is to record their events first and then show the video to a neurologist with longer working years through online consultation.

Study by Sophie Carlson [34], Home video telemetry with in-patient Video EEG in children, to look for acceptability of home video telemetry to caregivers and it's diagnostic accuracy, 76% caregivers preferred HVT.

Study by Oyieke,[35] Assess the utility of smartphone videos in diagnosis of pediatric epilepsy, Good quality videos assisted the differentiation of epilepsy from non-epileptic events with diagnosis made by more experienced clinicians

A study by Joseph O. Yaria [36], Use of home video recordings in a low resource setting in diagnosing epilepsy. Participants were required to fill a Pre-designed questionarre related seizure semiology which was compared with history, examination, EEG and neuro-images, Diagnostic accuracy for generalised and focal seizures increased from 73% to 85%.

Chen and colleagues [37] studied the usefulness of video versus EEG in isolation for the differentiation of epileptic seizures from psychogenic nonepileptic events. Experienced clinical epileptologists/ electroencephalographers blinded to the patients' clinical histories analyzed Video-EEG recordings of 43 events; 27 with epileptic seizures and 16 with psychogenic nonepileptic events. The videos and EEGs were scored independently by the same reader for each event. With video alone, the readers correctly identified epileptic seizures with a sensitivity of 93% and specificity of 94%. Based on EEG data alone, the readers correctly identified epileptic seizures with a sensitivity of 89% and specificity of 94%. Authors found that correct categorization of some neurobehavioral events could be made by experienced

epileptologists on the basis of video or EEG recordings during an event, without simultaneous review of both provided that the full event was recorded. Home video recordings were a useful screening tool for a subset of patients with neurobehavioral events of unclear etiology.

To overcome the limitation of lack of access to video-EEG monitoring as is common in many places**,** Erba and colleagues[38] investigated the role of video alone without the aid of EEG, in predicting the diagnosis of psychogenic non-epileptic seizures. Five neurologists practicing in epilepsy centers in Italy and the United States reviewed 23 videos of events from 21 unselected consecutive patients admitted for long-term video-EEG monitoring. All raters predicted the diagnosis correctly in 7 of 23 videos (30.4%), whereas all raters failed in 5 of 23 cases (21.7%). Authors concluded that a confident diagnosis of PNES/ES was possible on clinical grounds based on video data alone and these findings are particularly relevant to our country with limited access to video-EEG monitoring. We, in our study, heavily relied on videos to corroborate our classification of paroxysmal events into epileptic and non-epileptic before proceeding to further investigations such as EEG or neuroimaging.

Dozières-Puyravel et al[41] asked 19 participating child neurologists who were consulting children with epilepsy to fill online questionnaire to evaluate all videos that they watched in their clinical practice at initial or follow up visits. Based on the evaluation, 51% of the videos consisted of epileptic seizures; 40%, nonepileptic paroxysmal events; and 9%, psychogenic nonepileptic seizures. Most of the videos were made on parental initiative. The use of video has modified the first diagnosis hypothesis in 35% of cases. Authors of the study concluded that videos had become a part of the epilepsy clinic and were helpful for the diagnosis and follow-up of these children. This is much similar to our study, where we evaluated these videos in real-life situation of pediatric neurology practice.

The subspeciality of pediatric neurology in our country is a nascent one, and pediatric neurology services are still not available widely but are mostly restricted to some large academic centers or private hospitals. As a result, majority of the children are evaluated initially by a pediatrician or adult neurologist. We, therefore, wanted to assess the accuracy of diagnosis a pediatrician and an adult neurologist in comparison with that of a pediatric neurologist who had access to history, physical findings and videos. There was statistically significant difference (p=0.001) suggesting lack of their experience with wide variety of epileptic and non-epileptic disorders. Previous studies have also suggested that higher level of training and more numbers of years of experience in neurology resulted in enhanced accuracy in the diagnosis (Wassermann [28,] Huang [25)]

A study by Tatum et al [26] on assessment of the predictive value of outpatient smartphone video recordings for diagnosis of epileptic seizures included 44 adult outpatients who volunteered a smartphone video and subsequently underwent video EEG. Performance for smartphone video diagnosis by experts & trainees was compared with clinical diagnosis and video EEG was measured. Expert interpretation of a video recording was 89% accurate in predicting video EEG based diagnosis of the event. Clinical diagnosis when compared with home video recordings, diagnostic accuracy rose from 78.6% to 95.2%**.** Our study involved video reviews by 3 consultants including pediatric neurologist, adult neurologist and a pediatrician and final diagnosis (taken as gold standard, as video-EEG was not available on demand) was by pediatric neurologist. After video-review was added to the history and physical examination, non-epileptic events were diagnosed in 18 (31%) children compared with 10 (17%) (as per clinical diagnosis) a significant increase by 8 cases (13%). Diagnostic accuracy of video diagnosis by pediatrician, adult neurologist and pediatric neurologist was 89.66%, 84.2% and 94.83% respectively. Child neurologist among all the 3 experts had maximum sensitivity and specificity as he had a

specialised training, expertise with pediatric population, knowledge of developmental considerations, use of appropriate diagnostic tools.

A prior Video EEG monitoring study of 5 epileptologists analyzing 41 events (34 epileptic seizures) in 30 patients had an overall diagnostic accuracy of 65% using charted description and 88% with video, similar to our study[21]. There were videos in which we initially assumed a diagnosis of epileptic event based on clinical diagnosis but turned out to be a non-epileptic event with video diagnosis and final diagnosis turned out to be non-epileptic as well. Forty-three (74%) of events recorded were thought to be epileptic based on clinical diagnosis (misdiagnosed) turned out to be 40 (69%) epileptic events in final diagnosis of paroxysmal events. Smartphone videos added diagnostic value to clinical diagnosis, especially for patients with psychogenic nonepileptic attacks in our study and helped in preventing misdiagnosis of paroxysmal events.

Our study had several limitations. Our study had a small sample size. Though our study is one of its kind where children were evaluated in real-life situation of pediatric neurology OPD as and when they presented and had a prerecorded video with them, it was a time bound study over a period of one year, and included those children with paroxysmal disorders who had a home video recorded and was available for viewing. Similar children but without a home-video were not included or studied. We do not know the characteristics of these children and the type of paroxysmal events they had. Also, only the events which occurred at higher frequency and/or had longer duration, were more likely recorded causing recruitment bias. As2 a result, certain common diagnoses such as syncope, breath-holding spells are underrepresented. If patient had not had a recorded home video with them, and the diagnosis was not clear at initial presentation, we did ask the family to record video at home in case the event occurred again, but these children were not included in the study on follow up. Pediatric neurologist in the study was not blinded to the videos or clinical information of the patient, as he was the first contact and had access to

both type of information. Our study began around a time when covid-19 pandemic had just ended and patients were still reluctant to visit hospitals, resulting in slow and suboptimal recruitment. Not all home-video had recorded the full episodes from beginning to the end in many cases, it interfered with accurate classification of semiological features particularly of the epileptic events.

In summary, our study done in real-life clinical practice situation corroborates the value of home videos in the accurate diagnosis and classification of paroxysmal events. This resulted in better classification of epileptic seizures which informed further diagnostic and therapeutic interventions. In case of non-epileptic spells, enhanced diagnostic confidence bestowed by the home video was helpful in appropriate parental counselling and lessening their anxiety. It also helped curtail un-necessary investigations. Findings of our study are particularly useful in the context of developing countries like ours where resources are limited, expert pediatric neurology services are also sparse. There is need to study a large cohort of children with paroxysmal events to further confirm our findings.

LIMITATIONS

- Our study was limited by small sample size as it was time limited by constraints of being a thesis
- Parents had no prior training or instructions how to record the event. As a result not all videos recorded the complete episode(s) as parents switched on the camera after the event had begun and switched it off before the event had ended. Without recording the clear onset and the postictal period, a lot of useful information as missed which interfered with the clear differentiation into epileptic and non-epileptic events or characterization of individual events into a specific diagnosis.
- Similarly, some video did not have complete body exposure, and recorded only part of the body such as face or limbs only
- Awareness was difficult to ascertain as in many instances, patients were not being communicated to during the events.

Video-EEG is the gold standard of diagnosing and differentiating paroxysmal events. In our study, video-EEG was not possible because of resources limitation. Thus we compared video diagnosis with overall clinical assessment by the pediatric neurologist.

SUMMARY & CONCLUSION

Our study established that home videos are useful to aid differentiation between epileptic and non-epileptic seizures, especially when viewed by a more experienced clinician. We observed that with the easy availability of smart phones, parents were frequently able to record and bring event video to the clinician's attention. Majority of the videos were good quality aiding confirmation of clinical diagnosis as well providing alternative diagnosis in certain cases where a clinical diagnosis was non-conclusive or inaccurate. As a result, we were able to curtail unnecessary and costly laboratory investigations and guide early therapeutic interventions. Home video were generally possibly in those cases where paroxysmal events were frequent occurring almost on daily basis and were of sufficient duration to allow capture on smart phone. Home videos also allowed classification of epileptic events into generalized or focal seizures as well as subtyping into tonic, clinic, myoclonic etc. For non-epileptic events, diagnosis of specific disorder such as benign neonatal sleep myoclonus, gratification, breath-holding spells etc was made possible. In this study, we also found that a pediatric neurologist has enhanced accuracy of video diagnosis for non-epileptic disorders compared with a pediatrician and an adult neurologist, possibly resulting from enhanced knowledge and experience of dealing with children with paroxysmal disorders.

FUTURE DIRECTIVES

1. Standardised recording guidelines: Develop clearer guidelines for parents and caregivers on how to record events, including camera angles, duration, and the child's activity before, during, and after the event.
2. Integration with Telemedicine: Enhance telemedicine platforms to include features for uploading and securely sharing video recordings with healthcare providers.
3. AI and Machine learning: Invest in AI and machine learning tools to analyse video recordings, helping to identify and categorize different types of paraoxysmal events.
4. Educational programmes: Implement educational programmes for parents, caregivers, and educators on the importance of video recordings and how to capture them effectively.
5. Privacy and Data security: establish stringent privacy and data security measures to protect sensitive health information in video recordings.
6. Research and development: Encourage research into the efficacy of video recordings in diagnosing various paraoxysmal events and improving diagnostic accuracy.
7. Collaboration with Specialists: Foster collaboration between neurologists, pediatricians, and other specialists to standardize the use of video recordings in diagnostic protocols.
8. Accessible technology: Ensure that the necessary technology for recording and sharing videos is accessible to families from diverse socioeconomic backgrounds.

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KEY TO MASTER CHART

GENDER : F: Female and M: Male

Onset Insidious : I

Onset Sudden : S

Home/ School/ Others : H/S/O

Sleep/ Awake : S/A

Triggers : N : No trigger

Warning sign: N : No warning signs

Uprolled eyes, Clonic movemenmts, Stiffness : Y: yes/ N: no

UL/ BL : Unilateral/ Bilateral movements

G/F : Generalised/ focal

Aware to environment : Y : yes, N: no

Post event : N : normal

Family history, Birth history, Developmental history : N : Normal

General physical examination/ Systemic examination/ Neurological examination : NAD : No abnormality detected

CP : Cerebral palsy

EEG/ MRI : N : normal

VD: Video diagnosis

CD: Clinical diagnosis

FD: Final diagnosis

SB : Paediatrician in our study

JSG : Pediatric neurologist

GS: Adult neurologist

VD-SB, VD-JSG, VD-GS, CD, FD : Y : Yes epileptic, N : non epileptic

VD-SB, VD- JSG, VD-GS,CD, FD Categorisation given in below table :

1	Generalised tonic clonic seizures
2	Focal tonic clonic seizure
3	Epileptic spasms
4	Pseudo seizures/ Functional seizures
5	Myoclnous
6	Blepharospasm
7	Sleep myoclonus of infancy
8	Focal clonic seizures
9	Dystonia
10	Tetany
11	Shuddering attacks
12	Generalised tonic seizures
13	Subtle neonatal seizure
14	Inconclusive
15	Tremors
16	Multifocal clonic seizures
17	Gratification disorder
18	Absence seizure
19	Cyanotic spells/ Breath Holding spells
20	Night terrors
21	Binary (both epileptic and non epileptic)
22	Hand flapping

S. no.	MRD	Age (in months)	Gender	DOB	Onset Insidious	Onset Sudden	Home	School	Other places	Sleep	Awake	triggers	Warning sign	Uprolled eyes	UL/BL	Stiffness	Clonic	G/F	Special features	Aware to environment
1	1522140	12	F	19-02-2022	I	-	H	-	O	-	A	less sleep	vacant stare	Y	B	N	N	G	Salam spell	N
2	57395	10	F	30-12-2012	-	S	H	S	O	-	A	N	N	N	B	N	Y	F	Jaw movements	Y
3	1633721	9	F	13-07-2013	I	-	H	S	O	-	A	N	N	N	U	N	Y	F	Arm movements	Y
4	1450091	41	M	19-07-2019	-	S	H	S	O	-	A	N	N	N	B	N	Y	F	upward gaze f/b smile	N
5	1522003	10	M	08-12-2012	-	S	H	-	-	S	A	N	N	N	B	N	N	F	Shakes his arm	Y
6	1456789	13	M	10-03-2010	-	S	H	-	-	-	A	Emotions	N	N	B	N	N	G	Closed eyes	Y
7	1456432	17	F	01-02-2006	-	S	H	-	-	-	A	Emotions	LOC	N	B	N	N	G	lip movements voluntary	Y
8	145678	2	M	02-01-2023	-	S	H	-	O	S	A	N	N	N	U	N	Y	F	Eye twich	N
9	1536056	8	F	24-09-2015	I	-	H	S	O	S	A	N	N	Y	B	N	Y	G	Eye twich	N
10	1456743	12	M	10-01-2022	-	S	H	S	O	-	A	N	N	Y	B	Y	Y	G	Clinching of teeth	N
11	1583182	7	M	11-04-2023	I	-	H	-	O	-	A	less sleep	N	N	B	Y	N	G	Salam spell	N
12	1234876	14	F	16-06-2016	I	-	H	-	-	-	A	Emotions	Tickling	N	B	N	Y	F	Drooling of saliva	Y
13	1389653	6	M	19-05-2016	-	S	H	S	O	-	A	N	N	Y	U	Y	Y	F	Eye twich	N
14	1391033	12	F	10-09-2021	I	-	H	-	O	S	A	N	irritable	N	B	N	Y	G	Opsoclonus	Y
15	1345722	11	M	27-06-2011	-	S	-	S	-	-	A	Emotions	Pain abd	Y	B	Y	N	G	vacant stare	N
16	1438382	6	M	12-06-2022	-	S	H	-	O	-	A	N	N	Y	B	Y	N	G	Stops breathing	N
17	57395	10	F	17-12-2006	-	S	H	S	O	-	A	N	N	N	U	N	N	F	EYE Tremulness	Y
18	1388025	1	M	16-08-2022	-	S	H	-	-	S	A	N	N	N	U	N	N	F	Cyclical movements	Y
19	1446873	9	M	25-03-2021	I	-	H	-	O	-	A	N	N	N	B	N	N	G	Salam spell	N
20	1433775	15	M	06-10-2021	-	S	H	-	O	S	A	N	Hyperventilation	Y	B	Y	Y	G	Drooling of saliva	N
21	1511350	7	M	18-10-2022	-	S	H	-	O	-	A	less sleep	N	N	B	N	N	G	Salam spell	N
22	1394649	5	M	11-01-2017	I	-	H	-	-	S	A	N	N	Y	B	N	Y	G	Shakes his arm	N
23	1392490	9	M	22-01-2013	-	S	H	S	O	S	A	N	Visual aura	Y	B	Y	Y	G	Incontinence	N
24	1392611	11	F	27-11-2010	I	-	-	S	-	-	A	stress	N	Y	B	N	N	G	Eye blinking	Y
25	1470539	16	M	29-10-2021	-	S	H	-	O	S	A	N	N	Y	B	N	N	G	vacant stare	N
26	1566592	10	M	02-09-2022	I	-	H	-	O	-	A	N	N	Y	B	N	N	G	Body Shivering	Y
27	1566837	7	M	28-12-2022	-	S	H	-	O	-	A	N	N	N	B	Y	N	G	Body Shivering	Y
28	1567431	6	M	05-02-2023	-	S	H	-	O	-	A	less sleep	vacant stare	N	B	N	N	G	Salam spell	N
29	1575288	24	F	16-10-2021	I	-	H	-	O	-	A	N	N	N	B	N	N	G	Salam spell	N
30	1519530	4	F	28-12-2021	I	-	H	-	O	-	A	less sleep	N	N	N	N	N	G	Salam spell	N
31	1406328	14	M	23-01-2009	I	-	H	S	O	S	-	After meals	N	Y	B	N	Y	G	Shakes his arm	N
32	1407820	12	M	23-08-2021	I	-	H	-	O	-	A	N	N	Y	B	Y	Y	G	Clinching of teeth	N
33	1362282	3	M	12-07-2022	-	S	H	-	O	S	A	N	N	Y	U	N	Y	F	Eye twich	N
34	1503882	12	M	20-04-2022	-	S	H	-	O	-	A	N	N	Y	B	N	Y	G	Body Shivering	Y
35	1489825	4	M	29-11-2022	-	S	H	-	O	-	A	N	N	N	U	Y	Y	F	Jerks of right side	N
36	1524462	6	F	23-11-2022	-	S	H	-	O	-	A	less sleep	N	N	B	N	N	G	Salam spell	N
37	1534390	5	M	01-01-2023	-	S	H	-	O	-	A	N	N	N	U	N	Y	F	Shakes his arm	Y
38	1526101	28	F	28-01-2021	I	-	H	-	O	S	A	N	N	Y	B	Y	Y	G	jerky movements	N
39	1533545	5	M	12-04-2018	-	S	H	-	-	-	A	while playing	isolates himself	N	U	N	N	G	Unresponsive	Y
40	1545935	45	M	27-09-2019	-	S	H	S	O	S	A	N	N	Y	B	Y	N	G	Unresponsive	N
41	1146808	24	M	24-08-2020	I	-	H	S	O	-	A	N	N	N	B	N	N	G	Salam spell	N
42	1542326	3	M	11-04-2023	-	S	H	S	O	-	A	N	N	N	U	N	N	F	Eye blinking	N
43	1546879	0.8	F	11-06-2023	-	S	H	-	O	S	-	N	N	N	B	N	Y	G	only in sleep	N
44	1411239	24	M	03-11-2021	I	-	H	-	O	S	A	N	N	N	U	Y	Y	F	Arm movements	Y
45	1465560	5	M	20-09-2017	I	-	H	S	O	-	A	N	N	N	B	Y	Y	F	past h/o +	N
46	1418615	45	M	15-02-2019	-	S	H	-	O	S	-	N	N	Y	B	Y	Y	G	Incontinence	N
47	1325432	12	M	12-12-2021	-	S	H	-	O	S	A	less sleep	N	Y	B	Y	Y	G	Clinching of teeth	N
48	1447458	32	M	20-04-2020	-	S	H	-	O	S	A	Hyperventilation	vacant stare	N	B	N	N	G	jerks of arms	Y
49	1452395	12	M	23-01-2022	-	S	H	-	O	-	A	N	N	Y	B	Y	Y	G	Drooling of saliva	N
50	1452367	8	F	18-05-2022	-	S	H	-	O	-	A	N	vacant stare	N	B	N	N	F	Head nodding	Y
51	1500356	0.7	F	03-04-2023	-	S	H	-	O	S	A	N	N	N	B	N	Y	G	Arm movements	Y
52	489763	6	F	13-08-2016	-	S	H	-	-	S	A	Fever	N	Y	B	Y	Y	G	Clinching of teeth	N
53	1546890	12	F	01-07-2022	-	S	H	-	O	-	A	Crying	N	Y	B	Y	N	G	cyanosis	N
54	1536966	8	M	01-10-2022	-	S	H	-	O	-	A	less sleep	irritable	N	B	N	N	G	Salam spell	N
55	1504798	4	M	21-12-2022	-	S	H	-	O	-	A	less sleep	irritable	N	B	N	N	G	Salam spell	N
56	1505484	108	M	24-10-2013	-	S	H	-	O	S	-	N	N	N	B	N	Y	G	Leg jerks	Y
57	135432	36	F	12-07-2020	-	S	H	-	-	-	A	stress	N	N	B	N	N	G	Thigh chafing	Y
58	1410841	5	F	16-02-2017	I	-	H	-	O	S	A	N	vacant stare	N	B	N	Y	G	Arm movements	N

S. no.	MRD	post event	Duration(min)	freq per day	asso. Problems	Family h/o	Birth h	Development history	General Physical Examination	Systemic examination	Neuro exam	EEG
1	1522140	cry	<5	20	o	N	N	Delayed	Ash leaf macules	NAD	NAD	Hypsarrythmia
2	57395	N	<2	1	no	N	N	N	NAD	NAD	NAD	Epileptic
3	1633721	N	<1	2	no	Y	N	N	NAD	NAD	NAD	Focal epileptic
4	1450091	sleeps	<1	2	no	N	N	Delayed	NAD	NAD	NAD	N
5	1522003	N	<5	2	no	N	N	N	NAD	NAD	NAD	N
6	1456789	N	<1	2	no	N	N	N	NAD	NAD	NAD	N
7	1456432	N	<1	10	Death in family	N	N	N	NAD	NAD	NAD	N
8	145678	Lethargy	<1	5	no	N	N	N	NAD	NAD	NAD	Epileptic
9	1536056	N	<10	1/week	no	N	PNA/HIE	Delayed	ADHD	NAD	CP	Focal epileptic
10	1456743	Lethargy	<2	1/ week	no	N	N	N	NAD	NAD	NAD	Epileptic
11	1583182	cry	<1	1	irritable	N	PNA/HIE	Delayed	Microcephaly	NAD	Squint	Hypsarrythmia
12	1234876	Lethargy	<3	once/month	no	N	N	N	NAD	NAD	NAD	Epileptic
13	1389653	Lethargy	<1	3	vomiting	N	N	N	NAD	NAD	NAD	Focal epileptic
14	1391033	cry	<1	10	Ataxia	N	N	N	NAD	NAD	OMA	N
15	1345722	cant recall	<1	1	no	N	N	N	NAD	Obese	NAD	Focal epileptic
16	1438382	Cyanosed	<1	2	Adopted child	N	NK	Delayed	NAD	NAD	NAD	N
17	57395	Watery eyes	<5	5	no	N	N	N	NAD	NAD	NAD	N
18	1388025	Cyanosed	<2	10	no	N	N	N	NAD	NAD	NAD	N
19	1446873	cry	<1	10	no	N	Hypoglycemia	N	NAD	NAD	poor vision	Hypsarrythmia
20	1433775	Lethargy	<1	8	no	Y	N	N	NAD	NAD	NAD	N
21	1511350	cry	<1	6	no	Y	N	N	Ash leaf macules	NAD	NAD	Hypsarrythmia
22	1394649	sleeps	<10	10	Fever	N	N	Delayed	ADHD	NAD	NAD	Focal epileptic
23	1392490	Lethargy	<10	1	no	Y	N	N	NAD	NAD	NAD	Autoimmune enceph
24	1392611	N	<1	5	no	N	N	N	NAD	NAD	NAD	N
25	1470539	Lethargy	<1	2	Tongue myoclonus	N	N	Delayed	Hyperpigmention of body	Glossitis	Hypotonic	N
26	1566592	N	<1	12	no	N	PNA/HIE	Delayed	Microcephaly	NAD	Quadriplegic CP	N
27	1566837	N	<1	4	no	N	N	N	NAD	NAD	NAD	N
28	1567431	cry	<1	1	no	N	N	N	NAD	NAD	NAD	Hypsarrythmia
29	1575288	N	<11	3	TBM	N	N	Regression	NAD	NAD	Neuroregression	N
30	1519530	cry	<1	2	no	N	N	N	NAD	NAD	NAD	Hypsarrythmia
31	1406328	Lethargy	<1	2	no	N	N	N	NAD	NAD	NAD	Epileptic
32	1407820	Lethargy	<1	5	no	N	PNA/HIE	Delayed	Microcephaly	NAD	Quadriplegic CP	Epileptic
33	1362282	sleeps	<5	10	no	N	N	N	NAD	NAD	NAD	N
34	1503882	cry	<1	1	Fever	N	N	N	NAD	NAD	NAD	N
35	1489825	Lethargy	<1	3	Fever	N	N	N	NAD	NAD	Meningeal signs+	N
36	1524462	cry	<1	3	no	N	N	N	NAD	NAD	NAD	Hypsarrythmia
37	1534390	N	<1	4	no	N	N	N	NAD	NAD	NAD	N
38	1526101	limb weakness	<2	2	no	N	N	Delayed	NAD	NAD	NAD	Epileptic
39	1533545	recalls event	<5	1	no	N	N	N	NAD	NAD	NAD	N
40	1545935	cant recall	<1	1	no	N	N	N	NAD	NAD	NAD	Epileptic
41	1146808	Lethargy	<2	5	no	N	MSL/PNA/HIE	Delayed	Microcephaly	NAD	Quadriplegic CP	Hypsarrythmia
42	1542326	N	<1	2	no	N	RF/HMD	N	NAD	NAD	NAD	N
43	1546879	N	<2	2	no	N	N	N	NAD	NAD	NAD	N
44	1411239	sleeps	<10	0	no	N	PNA/HIE	Delayed	Microcephaly	Squint	diplegic CP	Epileptic
45	1465560	sleeps	<2	15	no	N	N	Delayed	NAD	NAD	NAD	gen. epileptic
46	1418615	sleeps	<15	0	Fixed interval	N	N	Delayed	ADHD	NAD	NAD	gen. epileptic
47	1325432	sleeps	<1	5	no	N	Hypoglycemia	Delayed	NAD	NAD	poor vision	gen. epileptic
48	1447458	N	<1	1	PICA	N	N	Delayed	ADHD	NAD	NAD	N
49	1452395	Lethargy	<10	0	no	N	N	N	NAD	NAD	NAD	N
50	1452367	N	<1	25	no	N	N	N	NAD	NAD	NAD	N
51	1500356	N	<1	6	Hypocalcemic sz	N	N	N	NAD	NAD	NAD	N
52	489763	Lethargy	<4	0	no	h/o seizures(father)	N	N	NAD	NAD	NAD	gen. epileptic
53	1546890	Lethargy	<5	0	no	N	N	N	NAD	NAD	NAD	N
54	1536966	cry	<3	5	no	N	PT/TWINS/RF	Delayed	NAD	NAD	NAD	Hypsarrythmia
55	1504798	cry	<1	6	no	N	PNA/HIE	Delayed	NAD	NAD	Floppy infant	Hypsarrythmia
56	1505484	N	<1	4	no	N	N	N	NAD	NAD	NAD	N
57	135432	N	<2	3	no	N	N	N	NAD	NAD	NAD	N
58	1410841	Lethargy	<5	20	Past h/o +	N	N	N	NAD	NAD	NAD	Absence sz

S. no.	MRD	MRI	Other tests	VD-SB-Y/N	VD-SB-type	VD-GS-Y/N	VD-GS-type	VD-JSG-Y/N	VD-JSG-type	CD-Y/N	CD-type	Final diagnosis	FD-type
1	1522140	TS	no	Y	3	Y	3	Y	3	Y	3	Y	3
2	57395	not done	no	N	4	N	4	Y	2	Y	2	Y	2
3	1633721	N	no	Y	2	Y	1	Y	8	Y	8	Y	8
4	1450091	N	N(exom seq)	Y	2	Y	2	Y	2	Y	2	Y	2
5	1522003	N	B12 n	N	4	N	4	N	22	Y	8	Y	14
6	1456789	N	no	N	4	N	4	N	4	N	4	N	4
7	1456432	N	no	N	4	N	4	N	4	N	4	N	4
8	145678	N	Ca: low	Y	13	Y	14	Y	2	Y	2	Y	2
9	1536056	PVL	no	Y	2	Y	2	Y	8	Y	8	Y	8
10	1456743	N	no	Y	1	Y	1	Y	8	Y	8	Y	8
11	1583182	N	no	Y	3	Y	2	N	14	N	14	Y	3
12	1234876	N	no	N	4	N	4	N	14	Y	18	Y	18
13	1389653	N	no	Y	2	Y	2	Y	8	Y	8	Y	8
14	1391033	N	Chest mri Neuroblastoma	N	5	Y	5	N	5	N	5	N	5
15	1345722	N	no	Y	1	Y	14	Y	2	Y	2	Y	2
16	1438382	N	no	Y	12	Y	12	N	19	N	19	N	19
17	57395	not done	no	N	6	N	6	N	6	N	14	N	6
18	1388025	N	WES: N	Y	13	Y	14	Y	5	Y	14	Y	5
19	1446873	OP damage	no	Y	3	Y	3	Y	3	Y	3	Y	3
20	1433775	N	WES: N	Y	1	Y	1	Y	2	Y	2	Y	2
21	1511350	TS	no	Y	3	Y	3	Y	3	Y	3	Y	3
22	1394649	N	no	Y	2	Y	1	Y	1	Y	2	Y	1
23	1392490	Internal capsule damage	no	N	4	Y	2	Y	1	Y	2	Y	2
24	1392611	N	no	N	4	Y + N	21	N	4	Y	14	N	4
25	1470539	N	B12: low	Y	9	Y	12	Y	8	N	15	Y	8
26	1566592	Hypoxic damage	no	Y	14	Y	14	Y	5 +18	Y	5	Y	5
27	1566837	not done	no	N	14	N	14	N	11	Y	12	N	11
28	1567431	N	no	Y	3	N	14	Y	3	Y	3	Y	3
29	1575288	N	no	N	14	N	14	N	9	Y	8	N	9
30	1519530	Microhaemorrhages	no	Y	3	Y	3	Y	3	Y	3	Y	3
31	1406328	N	no	N	20	N	14	N	14	Y	1	N	14
32	1407820	PVL	no	Y	12	Y	12	N	9	Y	12	N	9
33	1362282	N	no	Y	13	Y	13	Y	2	Y	2	Y	2
34	1503882	N	no	N	14	N	14	N	15	Y	1	N	15
35	1489825	Meningoencephalitis	csf: cmv+strepto pne	Y	2	Y	2	Y	8	Y	8	Y	8
36	1524462	N	no	Y	3	Y	3	Y	3	Y	3	Y	3
37	1534390	not done	Ca: N	N	14	N	14	N	15	Y	2	N	14
38	1526101	N	no	Y	1	Y	1	Y	1	Y	1	Y	1
39	1533545	N	no	N	14	N	14	N	14	Y	12	N	14
40	1545935	N	no	Y	2	Y	1	Y	2	Y	8	Y	2
41	1146808	Encephalomalacia	no	Y	3	Y	12	Y	3	Y	3	Y	3
42	1542326	Hypoxic damage	no	Y	13	N	14	Y	8	Y	8	Y	8
43	1546879	not done	Ca: N	N	7	N	7	N	7	N	7	N	7
44	1411239	PVL	no	Y	2	Y	1	Y	8	Y	8	Y	8
45	1465560	N	no	Y	1	Y	5	Y	1	Y	1	Y	1
46	1418615	N	no	Y	1	Y	2	Y	1	Y	8	Y	8
47	1325432	N	no	Y	1	Y	1	Y	2	Y	2	Y	2
48	1447458	N	Ferritin: N	N	14	N	5	N	5	Y	5	N	5
49	1452395	N	Ca: N	Y	1	Y	1	Y	16	Y	8	Y	16
50	1452367	not done	no	N	14	N	14	N	14	Y	5	N	5
51	1500356	not done	Vit D: low	Y	13	N	14	Y	16	Y	8	Y	16
52	489763	not done	no	Y	1	Y	2	Y	8	Y	8	Y	8
53	1546890	N	no	Y	1	Y	1	Y	2	Y	2	Y	2
54	1536966	Hypoglycemic injury	no	Y	3	Y	3	Y	3	Y	3	Y	3
55	1504798	PVL	no	Y	3	Y	3	Y	3	Y	3	Y	3
56	1505484	N	no	N	14	N	14	N	5	N	5	N	5
57	135432	not done	no	N	17	N	14	N	17	Y	12	N	17
58	1410841	N	no	Y	2	Y	2	Y	5	N	14	Y	5

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The Principal
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Subject:: **Approval of Plan of Thesis.**

This is to inform you that the Faculty of Medical Sciences in its meeting held on 25.09.2023 has approved the plan of thesis of **Savi Setia**, a student of your college for **MD Paediatrics** along with the names of Supervisor/Co-Supervisor as under:-

Topic Plan of Thesis
To study the value of home-videos in the diagnostic accuracy of paroxysmal events in children .

Supervisor	**Co-Supervisor:-**	Co-Supervisor:-
Dr. Jatinder Singh Goraya	Dr. Siddharth Bhargawa	Dr. Gagandeep Singh
Professor	Assoc. Prof.,	Prof. & Head
Dept. of Paediatrics (Neurology)	Dept. of Paediatrics	Dept. of Neurology

The student may submit the thesis in triplicate alongwith the plan in triplicate also, to the Controller of Examinations, BFUHS, Faridkot, at least six months before the commencement of theory examination, i he/she is otherwise eligible to take the examination. He /She may be directed to attach a photocopy of this lette with the forwarding letter while submitting thesis in the University along with the letter of approval of University for change of supervisor/Co-Supervisor, change of topic, if any.

Controller of Examinatio

Note :

1. *If any discrepancy found regarding topic of thesis or Supervisor/Co-Supervisor, inform undersigned within one month after issue of this letter.*

TO STUDY THE VALUE OF HOME-VIDEOS IN THE DIAGNOSTIC ACCURACY OF PAROXYSMAL EVENTS IN CHILDREN

THESIS PROPOSAL

FOR APPROVAL OF SUBJECT OF THESIS TO BE SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

MD

In

PAEDIATRICS

OF THE

BABA FARID UNIVERSITY OF HEALTH SCIENCES

FARIDKOT

AUGUST, 2022

DR. SAVI SETIA

DEPARTMENT OF PAEDIATRICS
DAYANAND MEDICAL COLLEGE AND HOSPITAL
LUDHIANA

ABSTRACT OF PLAN OF THESIS

Title	To study the value of home-videos in the diagnostic accuracy of paroxysmal events in children
For the degree of	MD PEDIATRICS
Name of the candidate	Dr. Savi Setia
Supervisor	Dr. Jatinder Singh Goraya, Professor, Department of Pediatrics Neurology, DMCH, Ludhiana
Co-Supervisor	Dr. Siddharath Bhargawa, Associate Professor, Department of Pediatrics, DMCH, Ludhiana Dr. Gagandeep Singh, Professor & Head, Department of Neurology, DMCH, Ludhiana.
Institution	Dayanand Medical College and Hospital,Ludhiana.
University	Baba Farid University of Health Sciences, Faridkot.

Introduction: A spell (paraoxysm) is an event, episode, or attack. In neurological context, a spell refers to episodic neurological symptoms that arise from transient alteration in motor, sensory, autonomic, cognitive, or psychic behavior.

The problem of misdiagnosis and missed diagnosis: Like epileptic seizures, non-epileptic events also involve intermittent and transient stereotyped alteration in cognitive, motor, sensory, autonomic or psychic behavior. It is, therefore, not surprising that non-epileptic spells are frequently misdiagnosed as epilepsy resulting in unnecessary investigations and potentially harmful treatments, often for very long periods as it may take years before correct diagnosis is discovered.

Approach to correct diagnosis: History furnished by the patient or witness is the most important, and often the only tool available to the physician to arrive at a diagnosis. Paroxysmal events are transient phenomena and almost always have no 'inter-ictal' tell-tale signs on physical and neurological examination. In the absence of video-EEG availability, direct observation of the event by the physician is the single most valuable clinical tool which not only help in identifying seizure from non-seizure events but also allows further characterization of individual events. Unfortunately, because of their nature, the paroxysmal events are rarely observed by the physician in the clinic. Certain paroxysmal disorders are easily recognized on video observation, thus obviating the need for costly diagnostic and therapeutic interventions.

Aim Of Study:1. To determine the spectrum of paroxysmal disorders diagnosed with home-videos. 2. To determine the proportion of children in whom the diagnosis of a paroxysmal disorder was confirmed or changed by home-videos.

Materials& methods: This will be a prospective observational study on children between 0 to 18 years of age children presenting with paroxysmal disorders to the pediatric department of DMCH, Ludhiana.

Clinical Significance:. Home-videos are expected to enhance the accuracy of diagnosis of a paroxysmal disorder by providing direct observation of the event.

Keywords: paroxysmal events, seizures, non-seizures, children.

(Signature) Candidate | (Signature) Co-supervisor | (Signature) Co-supervisor | (Signature) Supervisor | (Signature) Principal

CERTIFICATE OF FACILITIES AVAILABLE

This is to certify that the facilities for work on the subject of thesis titled **"TO STUDY THE VALUE OF HOME-VIDEOS IN THE DIAGNOSTIC ACCURACY OF PAROXYSMAL EVENTS IN CHILDREN"** exist in the Department of Pediatrics at Dayanand Medical College and Hospital, Ludhiana and will be provided to the candidate. We will see that the data being included in the thesis are genuine and is collected by the candidate herself under our supervision and guidance.

Supervisor

Dr. Jatinder S. Goraya
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DMCH, Ludhiana

Co-Supervisor's

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Place : _____

Date : _____

APPROVAL PROFORMA
BY RESEARCH & ETHICAL COMMITTEE
DAYANAND MEDICAL COLLEGE & HOSPITAL, LUDHIANA

Name of candidate	DR. SAVI SETIA
Department	PEDIATRICS
Topic of Thesis	TO STUDY THE VALUE OF HOME-VIDEOS IN THE DIAGNOSTIC ACCURACY OF PAROXYSMAL EVENTS IN CHILDREN
Likely date of appearing in PG examination	May/ June, 2024
Date of enrollment	5th March, 2022.
Name of Head of Department	Dr. Puneet Aulakh Pooni
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Signature of Members of Research Committee with Stamp	**Signature of Members of Ethics Committee with Stamp**
Dr. Harpreet Kaur (Professor & Head, Pathology)	Mr. R K Sharma (Legal Expert)
Dr. Jaspal Singh (Professor & Head, Surgery)	Dr. Ramit Mahajan (Associate Professor, Gastroenterology)
Dr. Dinesh Gupta (Professor & Head, Medicine)	Dr. Anu Sharma (Professor, Anatomy)
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	Dr. Gagandeep Singh (Secretary, Ethics Committee Professor & Head, Neurology)

Approved: Yes / ~~No~~

Dr. Sandeep Puri
Chairperson
Research Committee

Chairperson
Research Committee

Approved: Yes / ~~No~~

Prof. Arvind Malhotra
Chairperson
Ethics Committee

Chairperson
Ethics Committee

BABA FARID UNIVERSITY OF HEALTH SCIENCES, FARIDKOT

PROFORMA FOR REGISTRATION OF SUBJECT FOR DISSERTATION

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2	NAME OF THE INSTITUTE	Dayanand Medical College & Hospital, Ludhiana
3	COURSE OF STUDY AND SUBJECT	MD Pediatrics
4	DATE OF ADMISSION OF COURSE	05/03/2022
5	TITLE OF THE TOPIC	To study the value of home-videos in the diagnostic accuracy of paroxysmal events in children

6.1 NEED FOR THE STUDY:

A spell (paraoxysm) is an event, episode, or attack. In neurological context, a spell refers to episodic neurological symptoms that arise from transient alteration in motor, sensory, autonomic, cognitive, or psychic behavior.[1,2]

A population based prospective study that included children only up to 12 months of age, found the incidence of paroxysmal disorders between 8.9% to 12.9% with epilepsy accounting for a very small fraction.[2]

Paroxysmal disorders are common in children at all ages and are commonly differentiated into seizures and non-seizure events, with each category having further sub classifications. A clear distinction between the two types is of paramount importance and required comprehensive history from the care giver or eyewitness. Physical examination adds little to the diagnosis, as the interictal period is generally without any diagnostic clinical signs. In children with funny turns referred to secondary care, the diagnostic possibilities are numerous; among non-epileptic events, syncopes predominate. The majority do not have epilepsy. Unclassifiable events with no clear epileptic or non-epileptic cause are common and can be safely managed expectantly. [3]

Though video-EEG is the gold standard of evaluation of paroxysmal disorders, the facilities for such an intervention are not easily available in countries like ours. As a result, not infrequently, it become difficult to reliably distinguish between the different types of events, resulting in (mis) diagnosis with non-seizure events being diagnosed as seizures and vice versa.

All other paroxysmal events that are not seizures, are included under the umbrella term of non-epileptic spells, also called non-epileptic events (NEE), non-epileptic paroxysmal disorders (NEPD), paroxysmal non-epileptic disorders (PNED), paroxysmal non-epileptic events (PNEE), imitators of epilepsy or simply seizure mimics. [4-7]

The non-epileptic spells have an outward semiological resemblance with seizures but are not caused by excessive discharge of cortical neurons. Pathophysiological mechanisms involved in the genesis of non-epileptic spells are varied and can arise both in and outside the CNS. [,8,9]

Seizures and epilepsies are further classified according to the well-known systems of classification of seizures and epilepsies by International League against Epilepsy (ILAE). [10,11]

Wrong diagnosis may also initiate a cascade of inappropriate investigations and therapeutic interventions with potential for bodily and psychological harm. It is, therefore, of utmost importance to carefully evaluate, investigate, diagnose, differentiate, and treat paroxysmal events in children to minimize the diagnostic errors and therapeutic misadventures. [12]

On the other hand, non-epileptic spells in the absence of an agreed-upon systems of classification, have been classified variously according to the age of onset, pathophysiology, mode of presentation and whether occurring during wakefulness or sleep.[12}

In clinical practice, however, misdiagnosis of nonepileptic spells as epilepsy is fairly common and often is a result of incomplete history-taking. [12]

“Spells” seldom remain unexplained when viewed. Because observation of the spell is critical to diagnosis, ask the family to record the spell. Most families either own or can borrow a camera or a cell phone with video capability. Even when a purchase is required, a video is often more cost effective than brain imaging and the family has something useful to show for the expenditure. Always ask the following two questions: Has this happened before? Does anyone else in the family have similar episodes? Often, no one offers this important information until requested. Episodic symptoms that last only seconds and cause no abnormal signs usually remain unexplained and do not warrant laboratory investigation. [13]

Non-epileptic spells are far more common than epileptic spells. While incidence of epilepsy has been assessed at 50.4 per 100,000 per year,[14] similar studies to ascertain the incidence of non-epileptic spells in children are lacking.

The prevalence of paroxysmal phenomena in the first two years of life was assessed in 1854 children of Dutch-speaking mothers of a population-based birth cohort. At each visit to the Child Health Clinic

(CHC), mothers were asked whether they had noted sudden change of consciousness, involuntary movements, deviation of the eyes or apnoea, and if so, whether these appeared to be related to feeding. Paroxysmal episodes occurred in a quarter of the children; in 8 per cent only in relation to feeding, in 19 per cent also not related to feeding. The latter children were more frequently admitted to hospital and had more disabilities at age two years [15]

There are not many studies that have looked at the role of home-based video in differentiating seizure and non-seizure events in children. Therefore, we planned this study to investigate the value of mobile phone videos in confirming and increasing diagnostic accuracy of paroxysmal events in children.

The problem of misdiagnosis and missed diagnosis: Like epileptic seizures, non-epileptic events also involve intermittent and transient stereotyped alteration in cognitive, motor, sensory, autonomic or psychic behavior. [2] It is, therefore, not surprising that non-epileptic spells are frequently misdiagnosed as epilepsy resulting in unnecessary investigations and potentially harmful treatments, often for very long periods as it may take years before correct diagnosis is discovered. [16] Equally important but less prevalent than misdiagnosis of epilepsy is the problem of missed diagnosis of epilepsy.[5] This may lead to false assurance that epilepsy does not exist, and the child deprived of effective antiepileptic medications. Wrong diagnosis may also initiate a cascade of inappropriate investigations and therapeutic interventions with potential for bodily and psychological harm. It is, therefore, of utmost importance to carefully evaluate, investigate, diagnose, differentiate, and treat paroxysmal events in children to minimize the diagnostic errors and therapeutic misadventures. [12] The diagnosis of epilepsy is primarily based on the history and the verbal description of the events in question. Smartphone videos are increasingly used to assist in the diagnosis. The purpose of this study is to evaluate their value for the diagnosis of seizures. We prospectively collected smartphone videos from patients who presented to our epilepsy center over two years. [17] Home videos made on mobile phones are a cost-

effective tool for the diagnosis of paroxysmal events in infants. They can facilitate the diagnosis of paroxysmal events in infants and thereby save costs. The best choice for infants with paroxysmal events on their initial visit is to record their events first and then show the video to a neurologist with longer working years through online consultation.[18]

Psychogenic nonepileptic seizures (PNES) are episodes that may resemble epileptic seizures (ES) but are not associated with abnormal electrical discharges in the brain. Video-EEG recording of a typical episode is considered the best diagnostic tool available. PNES are, however, also documented in patients with epilepsy (PNES/ES). The purpose of this study was to assess this comorbid population, focusing on the differences between patients with PNES/ES and patients with PNES alone.[19]

6.2REVIEW OF LITERATURE

Use of home videos in recording the events is a recent phenomenon parallel with the advent and advancement of the smart phone technology which has made mobile telephony ubiquitous and a common household and portable (personal) gadget. Smart phones are easy to operate (require little if any training) and have capabilities to capture detailed motor and other behaviors. The literature on the subject is very recent and several studies attest to their usefulness in the diagnosis and differential diagnosis of both epileptic and non-epileptic events, importance of which can never be over emphasized.

Amin et al. compared the diagnosis based on smartphone videos to the final diagnosis based on standard video-EEG monitoring. Of the 54 adult patients (mean age 34.7 years and 59% female) included in the study, 36 had conclusive data (both on smart phone videos and video-EEG monitoring), and 18 nonconclusive. Cell phone video and video-EEG were in agreement in 34 (94%). Of these, 13 had epileptic and 23 non-epileptic spells. Authors concluded that smartphone videos were useful adjunctive tool in the diagnosis of seizure-like events.[20]

Gowda and colleagues from South India prospectively studied nonepileptic events in children up to 18 years of age. A total of 3660 children presented with paroxysmal events, out of which 285 (8%) had non-epileptic events. Home videos were helpful in the recognition of type of non-epileptic events in 35% children.[21]

Huang et al., from China tasked 452 practitioners to evaluate clinical descriptions and home video of paroxysmal events from 12 infants. They made their diagnosis of the events first from clinical descriptions and then from corresponding home videos. The mean correct diagnoses with videos were 8.4 (SD 1.7) of 12 and without videos 7.5 (SD 1.7) of 12. For epileptic events, mobile phone videos increased the mean accurate diagnoses by 3.9% and for nonepileptic events, it increased 11.5%. The results were statistically significant. Pediatric neurologists with longer working years had higher diagnostic accuracy. There was significant cost saving. The authors concluded that home

videos made on mobile phones were a cost-effective tool for the diagnosis of paroxysmal events in infants.

Ramanujam and colleagues from India studied the contribution of smart phone-based home videos in the diagnosis of psychogenic non-epileptic seizures in patients aged between 10-50 years. Home videos contributed to the correct differentiation between psychogenic non-epileptic seizures, epileptic seizures, and other physiological events in 49% for all videos and 71% for good or fair quality home videos. Home-videos diagnosis of psychogenic non-epileptic seizures had sensitivity of 95.4%, specificity of 97.5%, and positive and negative predictive values of 92.65% and 98.5% respectively. Authors concluded that home-videos of good quality could complement VEEG in diagnosing PNES in a cost-effective way and help initiate appropriate management.[20]

In a prospective, multicentre cohort study to evaluate smart phone video quality in adult patients with paroxysmal neurological events, Tatum et al., found that smartphone video quality is adequate for clinical interpretation in the majority of patients with paroxysmal neurologic events. Videos were reviewed by experts and senior neurology residents. Accuracy improved with the presence of convulsive features from 72.4% to 98.2% for epileptic seizures, and from 71.1% to 95.7% for psychonic non-epileptic attacks. Authors reached the conclusion that smartphone video quality was adequate for clinical interpretation in the majority of patients with paroxysmal neurologic events. [18]

Similarly, Uzunahn concluded that home video recordings can prevent a misdiagnosis of epilepsy in patients with recurrent non-epileptic paroxysmal disorders. The author studied 75 (aged 2 months to 69 months; 39 male) pre-school children with non-epileptic paroxysmal disorders. Breath-holding spells was the most common diagnosis noted in 29 (39%) children. Home video was most useful in patients with gratification disorder.[19]

Prior to the arrival of smart phones, Samuel and Duncan studied utility of handheld video camcorderin the evaluation of suspected seizure or

seizure like events. The videotapes assisted the diagnosis of non-epileptic attacks in 9 of 22 patients (41%) and of epileptic attacks in 8 of the 22 patients (36%). It was concluded that the handheld video camera was useful tool in providing accurate description of seizures.[22]

6.3 AIMS AND OBJECTIVES OF THE STUDY

1. To determine the spectrum of paroxysmal disorders diagnosed with home-videos.
2. To determine the proportion of children in whom the diagnosis of a paroxysmal disorder was confirmed or changed by home-videos.

7. MATERIALS AND METHODS:

Study site: The study will be carried out in the Department of Pediatrics, Dayanand Medical College and Hospital, Ludhiana

Choice of Subjects: Paroxysmal disorder will be defined as any episode of neurological symptoms characterized by transient alteration in motor, sensory, autonomic, cognitive, or psychic behavior. All children with new-onset spells will be included. Both epileptic and non-epileptic events will be included. Following inclusion and exclusion criteria will be employed:

7.1 SOURCE OF DATA

Children attending the pediatric outpatient will be the source of data. All children with seizures or seizure-like presentation will undergo detailed historical interrogation and physical examination to determine the nature of episodes.

7.2 METHOD OF COLLECTION OF DATA

Data will be prospectively collected on structure proforma

Inclusion Criteria:

- Age 0 years to 18 years
- Gender: either
- New onset spell. For children with a known paroxysmal disorder, new type of spells will be included in the study
- **Availability of home video recorded on smartphone or other devices such as CCTV**

Exclusion Criteria

- No home video available
- Available video is of poor quality
- Parents' refusal to participate.

The selected children meeting the inclusion criteria will undergo detailed clinical evaluation by history and physical examination. Laboratory investigations will be dictated by clinical suspicion of the underlying cause of spells. Similarly, neuroimaging and electroencephalography (EEG) will be done on the basis of results of clinical evaluation.

DURATION OF STUDY: 1 year from the date of approval of plan of thesis by the respective committes

CONSENT: Will be obtained as appropriate.

OUTCOME: Will depend on the recorded videos.

STATISTICAL ANALYSIS: - Data will be described in terms of range; mean ±standard deviation (± SD), median, frequencies (number of cases) and relative frequencies (percentages) as appropriate. To determine whether the data is normally distributed, a Kolmogorov-Smirnov test will be used. Comparison of quantitative variables between the study groups will be done using Student t-test and Mann Whitney U test for independent samples for parametric and non-parametric data respectively. For comparing categorical data, Chi square ($\chi 2$) test will be performed and fisher exact test will be used when the expected frequency is less than 5. A probability value (p value) less than 0.05 will be considered statistically significant. All statistical calculations will be done using (Statistical Package for the Social Science) SPSS 21version (SPSS Inc., Chicago, IL, USA) statistical program for Microsoft Windows.

7.3 DOES THE STUDY REQUIRE ANY INVESTIGATIONS OR INTERVENTIONS TO BE CONDUCTED ON PATIENTS OR OTHER HUMANS OR ANIMALS? IF SO, PLEASE DESCRIBE BRIEFLY.

No

7.4 HAS ETHICAL CLEARANCE BEEN OBTAINED FROM YOUR INSTITUTION IN CASE OF 7.3?

Yes, Attached herewith.

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PROFORMA

Sr. No.

Name: Age/Gender: Date of Birth:

MRD No.

Date of encounter:

Referring Diagnosis:

Event description

Onset:

Settings: Home/School/Others

Circumstances of occurrence: Awake/Sleeping

Anytriggers or provoking factors: describe if any

Any warning symptoms: describe if any

Event description (detail of event and sequence):

Post-event condition: describe if any

Duration of event:

Frequency of event:

Any other information

Family History:

Birth history: Normal/ Abnormal (describe if abnormal)

Development: Normal/Delayed (describe if abnormal)

Examination

General Physical Exam

Systemic Exam

Neurological Exam

Investigations:

EEG

CT/MRI

Others:

Clinical diagnosis

Video diagnosis

			If epileptic, type of seizure	If non-epileptic, Specific category
	Epileptic	Non-epileptic		
Observer 1 (SS)				
Observer 2 (SB)				
Observer 3 (GS)				
Observer 4 (JG)				

Final diagnosis:

INFORMED PATIENT CONSENT

Date: _____

I…….D/o, W/o, S/o……..…… am willing to participate in the study **"TO STUDY THE VALUE OF HOME-VIDEOS IN THE DIAGNOSTIC ACCURACY OF PAROXYSMAL EVENTS IN CHILDREN"** The procedure with its complications has been explained to me in local vernacular language. I have fully understood that no special tests and extra expenditure in any form, merely for the purpose of thesis is being carried out. I am free to opt out the study any time without assigning any reason.

……. ……
Signature of the Witness Signature of the patient

Name:

Signature of Candidate **Signature of Supervisor**

मरीज अनुमति फार्म

तिथि _____

मैं _____ पत्नी/पुत्र/पुत्री _____
निवासी _____
इस शोधकार्य **"TO STUDY THE VALUE OF HOME-VIDEOS IN THE DIAGNOSTIC ACCURACY OF PAROXYSMAL EVENTS IN CHILDREN"** में भाग लेने के लिए सहमत हूँ। मैं इस शोधकार्य में भाग लेने के लिए अपनी स्वेच्छा से तैयार हूँ। मैं पुष्टि करता/करती हूँ की यह स्वीकृति देने के लिए मुझे कोई आर्थिक प्रलोभन नहीं दिया गया और न ही दबाव डाला गया है। मुझे इस शोधकार्य का उद्देश्य स्पष्ट कर दिया गया है और मुझे यह विश्वास है की यह विज्ञान और मानवता के लाभ के लिए है। मुझे इस शोधकार्य में होने वाले जोखिम के बारे में समझा दिया गया है और मेरी समझ में यह जोखिम बहुत मामुली है।

मैं इस शोधकार्य में भाग लेने के सम्बन्ध में किसी भी समय अपनी अस्वीकृति व्यक्त कर सकता/सकती हूँ और मेरे अस्वीकृति व्यक्त करने का मेरे इलाज पर कोई प्रभाव नहीं पड़ेगा।

_____	_____
गवाह के हस्ताक्षर	रोगी के हस्ताक्षर/अंगूठे का निशान
नाम:	नाम:

_____
अन्वेषक के हस्ताक्षर

_____
विद्यार्थी के हस्ताक्षर

ਮਰੀਜ਼ ਰਜ਼ਾਮੰਦੀ ਫਾਰਮ

ਮਿਤੀ_____

ਮੈ_____ਪਤਨੀ/ਪੁੱਤਰ/ਪੁੱਤਰੀ_____

ਵਾਸੀ _____

“TO STUDY THE VALUE OF HOME-VIDEOS IN THE DIAGNOSTIC ACCURACY OF PAROXYSMAL EVENTS IN CHILDREN” ਤੇ ਚਲ ਰਹੀ ਖੋਜ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਰਜ਼ਾਮੰਦ ਹਾਂ। ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਮੈ ਆਪਣੀ ਮਰਜ਼ੀ ਨਾਲ ਤਿਆਰ ਹਾਂ। ਮੈ ਇਹ ਦਸਣਾ ਚਾਹੁੰਦਾ ਹਾਂ/ ਚਾਹੁੰਦੀ ਹਾਂ ਕੇ ਇਹ ਰਜ਼ਾਮੰਦੀ ਦੇਣ ਵਾਸਤੇ ਮੈਨੂ ਕਿਸੇ ਵੀ ਤਰਾਂ ਦਾ ਲੋਭ-ਲਾਲਚ ਨਹੀ ਦਿੱਤਾ ਗਿਆ ਅਤੇ ਨਾ ਹੀ ਕੋਈ ਦਬਾ ਪਾਇਆ ਗਿਆ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਦਾ ਮਨੋਰਥ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਭਰੋਸਾ ਦਵਾਇਆ ਗਿਆ ਹੈ ਕੇ ਇਹ ਖੋਜ ਵਿਗਿਆਨ ਅਤੇ ਮਾਨਵਤਾ ਦੀ ਭਲਾਈ ਲਈ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਵਿਚ ਹੋਣ ਵਾਲੇ ਖਤਰੇ ਬਾਰੇ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਯਕੀਨ ਹੈ ਕੇ ਇਹ ਖਤਰਾ ਬਹੁਤ ਮਾਮੂਲੀ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਦਾ ਢੰਗ – ਤਰੀਕਾ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ।

ਮੈ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਬਾਰੇ ਆਪਣੀ ਰਜ਼ਾਮੰਦੀ ਕਿਸੇ ਵੀ ਸਮੇ ਵਾਪਸ ਲੈ ਸਕਦਾ ਹਾਂ/ ਸਕਦੀ ਹਾਂ ਅਤੇ ਮੇਰੀ ਰਜ਼ਾਮੰਦੀ ਵਾਪਸ ਲੈਣ ਦਾ ਮੇਰੇ ਇਲਾਜ ਤੇ ਕੋਈ ਅਸਰ ਨਹੀ ਹੋਵੇਗਾ।

_____ _____

ਗਵਾਹ ਦੇ ਹਸਤਾਖਰ ਮਰੀਜ਼ ਦੇ ਹਸਤਾਖਰ

ਮਿਤੀ_____ ਮਿਤੀ_____

ਪਤਾ _____ ਪਤਾ _____

_____

ਨਿਰੀਖਕ ਦੇ ਹਸਤਾਖਰ

_____

ਸਿਖਿਆਰਥੀ ਦੇ ਹਸਤਾਖਰ